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EXPERIMENTS WITH VACUUM TUBES.

At a meeting of the Philosophical Society of Glasgow on December 22, 1880, I gave a very brief preliminary account of some experiments that I have been making, along with Sir William Thomson, with vacuum tubes. We have sealed up English and German glass tubes with very high vacuums, but without any electrodes; and have obtained very remarkable luminous effects both with the Ruhmkorff coil and also working by means of electrostatic induction. Using an ordinary frictional electric machine, and applying one end of a long vacuum tube to the prime conductor, while the other end of the tube is held in the hand, the tube becomes charged as a double Leyden jar in the following way: one end of the tube, next to the prime conductor, outside positive, inside negative; the other end, inside positive, outside negative. This can be shown by the gold leaf electroscope. The charges seem to be very high and the glass is very frequently perforated. Indeed it is difficult to work with the electric machine in tolerably good order without perforating the glass. While this double Leyden jar is slowly discharged by removing part by part the charges from the outside of the tube, beautiful luminous effects are observed very different from those seen in the ordinary vacuum tubes. We have also obtained curious effects by heating the middle region of the tube so highly that it becomes a semi-conductor. —*J. T. Bottomley, in Nature.*

PHYSICS WITHOUT APPARATUS.

During a lecture course by professors who have at their disposal a complete set of physical apparatus, there are some experiments performed by them which at first sight seem very complicated, but which nevertheless may be repeated by means of very simple objects. There is, for instance, the interesting Lissajous experiment, which consists, as the reader is well aware, in throwing on a screen, by means of the oxyhydrogen lamp, the curves traced by one of the arms of a tuning fork in sonorous vibration. An analogous experiment may be exhibited by means of a common knitting needle. Fix one of the extremities of the needle in a cork to serve as a base; then to the upper free extremity attach a ball of sealing wax, and on this gum a small circle of paper about the diameter of a pea. Now, holding the cork firmly between the fingers of the left hand, cause the needle to sharply vibrate, either by bending it far to one side and then suddenly releasing it, or by striking it smartly with a wooden ruler. The little ball of wax surmounted by paper will be seen to describe a more or less elongated ellipse, or a circle, according to the intensity or the number of vibrations. The phenomenon is very perceptible when care is taken to cause the needle to vibrate under a strong light from a lamp; and, in such a case the persistence of the impression on the retina causes the vibrating wire to form an image which has the appearance of a long and graceful bouquet holder, or a champagne glass (Fig. 1).

Among the experiments sometimes performed to demonstrate molecular attraction, there is one which is executed by means of an apparatus of a peculiar structure; but the same phenomenon may be shown in a much more simple manner, as follows: Having cut two small spheres out of a bottle cork, place them on the surface of water. If one of the balls now carefully be pushed along until it is in quite close proximity to the other, the two will be seen to quickly rush toward each other, just as a bit of iron flies to a magnet when the latter is brought near it. The experiment may be varied by fixing one of the balls to the point of a knife and using it to attract the other ball when floating at a short distance (Fig. 2).

In a former article has been described how an electric spark may be obtained by means of a sheet of paper and a bunch of keys. A writer in a recent number of *Nature* has pointed out a neat method of obtaining the same result by means of a simple apparatus which he calls the "tea-tray electrophorus" (Fig 3). A common metallic tea-tray is supported on two dry glass goblets. A piece of common brown paper cut so as to be a little smaller than the tray, and with rounded corners, is warmed, laid on the table and rubbed briskly with a piece of India-rubber, or with a clothes brush. It is then laid down for an instant on the tray, and the latter is touched with the hand. The paper is then lifted a few inches above the tray. If at this juncture some person presents his knuckle to the tray he will receive a bright spark, which under favorable circumstances may be a couple of inches long. By simply putting the paper down, touching the tray, and again lifting up the paper, the tray is again charged, and a large number of sparks may be thus drawn one after the other in rapid succession. The paper may be lifted by the hands, but it will be found better if a couple of strips of paper be fixed on with wax to serve as handles, as shown in the figure.

Fig. 1.—EXPERIMENT ON VIBRATION.

The sparks obtained by the tea-tray electrophorus may produce a slight pricking sensation, but to give a regular electric shock will oblige us to store up a charge in a Leyden jar. This important piece of apparatus may be improvised as follows: A round-bottomed glass tumbler is procured—thin glass is preferable—and is filled about three-quarters full of small leaden shot. If shot is not at hand *dry* coal dust will answer, though not so well, and great care must be taken to wipe clean the upper part of the tumbler. Everything must be warm and scrupulously dry. Into the shot is inserted a silver spoon to serve the place of a rod and knob. The tumbler is held, as shown in Fig. 4, by grasping it well in the bottom of the hand, so that the palm may cover the whole of the rounded bottom. Having thus prepared and grasped the improvised Leyden jar, it is to be charged with sparks from the tea tray electrophorus. It should be held with the spoon-handle near to, but not quite touching the edge of the tea-tray, while another person performs the operations of lifting the paper up and putting it down, then touching the tray, then lifting up again, and so on until a dozen sparks have been sent into the jar. On touching the "knob" a smart little shock is experienced in the wrists and elbows, and a short, bright, snapping spark announces the discharge of the jar.

APPLICATION OF THE ELECTRIC LIGHT AT THE ANGERS (FRANCE) SLATE QUARRIES.

In 1832 the Société des Grands Caneaux undertook the first subterranean exploitation of the important slate deposits of Marne-et Loire. After working these nearly fifty years, the quarries, with their galleries running in every direction, have reached an immense depth. The only circumstance that has been found relatively disadvantageous in these underground works is that of the darkness which prevails therein, and which renders the work of the laborers less advantageous and a surveillance of the walls quite difficult. This inconvenience was remedied at first by the substitution of gaslight for the miners' smoky lamps formerly used, and more recently by the application of the electric light, which, indeed, appears to completely solve the problem. The history of these different improvements in lighting is given by M. Blavier, in the *Annales des Mines*, and from this we make the following extracts:

The first gas works were erected in 1847 at the Fresnais Quarry for lighting chamber No. 1, and consisted of one cast-iron retort and one gasometer. When the possibility of sending the gas down to a depth of 650 feet was discovered, and when the superiority of this mode of lighting the subterranean chambers was recognized, the works in the course of the year 1855 were enlarged and equipped with two furnaces of three retorts each—each having two gasometers and the most approved purifying apparatus connected with it. The cost of this establishment was about $6,000. This lighting by gas, however, served only for lighting up the subterranean chambers in a general way, as well as the shaft, but did not suffice for the work of the miner, who was obliged to have constantly beside him his hand lamp. Thus the expense of oil had to be added to that of the gas. The improvement effected by the use of gas, however, was considerable. It allowed the miners to move about without danger, and permitted the superintendents to keep surveillance over the work in progress. The light was, doubtless, a little diffused, but it was sufficient to allow the walls and vaults of the chamber to be seen, and thus it removed that natural apprehension of danger that the miners were apt to feel when working in darkness. The slate companies, however, notwithstanding these improvements and the great cost of the same, began at once to look into the merits of the electric system of lighting as soon as this entered the domain of practice. Some practical tests were made about fifteen years ago, but, owing to a failure to come to terms with the Alliance and other companies, no definite action was taken until 1878. At this period occurred the Paris Exhibition. As a consequence of the economical results obtained with the electric light at this exhibition, and of the improvements introduced therein by the use of the Gramme magneto-electric machine, the Slate Quarry Commission took up the question anew, and decided on the 30th of August, 1878, that an exhaustive trial should be made with these machines at the Fresnais Quarry. After several months spent in determining on the best practical arrangements to adopt for the motor, the lamps, and the electric conductor, the problem was solved by M. Blavier, the engineer, in a manner which left little to be desired. An expansion engine of a nominal sixteen horse power was installed, along with two generators, for driving the six magneto-electric machines necessary for lighting the three subterranean chambers of the quarry. New conducting cables were made, partly of seven No. 18 copper wires, weighing about 5·5 ounces to the foot,

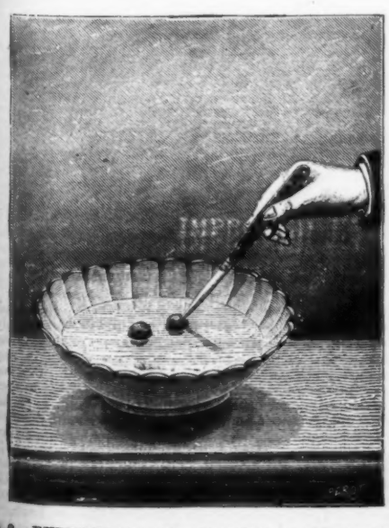


Fig. 2.—EXPERIMENT ON MOLECULAR ATTRACTION.

Fig. 3.—THE TEA TRAY ELECTROPHORUS.

Fig. 4.—THE LEYDEN JAR.

and having a section of 2·5 square inches, and partly of nineteen No. 13 wires, weighing about 4·5 ounces to the foot, and having a section of 2·3 square inches. These cables, which were 1,150 feet in length, were not covered externally, experience having shown that a wrapping of tarred flax deteriorates very rapidly, and thus proves more injurious than useful. The gas-coke carbons of the lamps were replaced by artificial carbons, which were more homogeneous, not so fragile, and which gave a more beautiful and regular light. With these various improvements successively introduced, chamber No. 10 of the Fresnais Quarry has been lighted for several months already without any other interruption than that of two hours' stoppage out of the twenty four, in order to give the motor and other apparatus the necessary attention to keep them in order. The daily consumption of coal has been reduced precisely one-half. The light furnished by two lamps, without reflectors, placed at about 35 feet from the end excavation and on each side of the gallery, is bright enough to render possible all the work done over a surface of more than 6,000 square feet without the aid of oil lamps. The light possesses more steadiness than gas, which was nearly always extinguished at the moment any blasting took place, and, finally, it gives off neither smoke nor deleterious gases, so that the atmosphere of the chamber is rendered purer and more transparent. The results obtained, then, are very important, regarded from the standpoint of exploitation, and they are none the less so from an economical point of view. The lighting of a subterranean chamber of 6,000 square feet of surface, like the one just mentioned, requires the use of the following electrical apparatus: Two Gramme machines, three Serrin

THE FRENCH INTERNATIONAL ELECTRICAL EXHIBITION.

THE French Government has appropriated sixty thousand dollars toward the organization of an International Exhibition of Electricity, which is to be opened Aug. 1, 1881, in the Palace of the Champs Elysées.

The Committee of Organization consists, according to the *Journal Officiel*, of the following gentlemen:

President—M. Cochery, Minister of Posts and Telegraphs.

Vice-Presidents—Vice-Admiral Pothuau, Teisserenc de Bort, Brisson, and M. De Lesseps.

Members—MM. E About, Allard, Alphand, Bapst, Baron, Barral, Becquerel, Bergon, Bert, Berthelot, Blavier, Bouilhet, Breguet, Carnot, Cernesson, Charmes, de Choiseul, Cornu, Crozet-Fourneyron, Cuvinot, Daubrée, Delaitre, Demachy, Denion du Pin, Dietz-Monnin, Develle, Dumas, Dumont, Dupuy de Lôme, Durrieu, Faye, Gaillimard, Garnier, Gendarme de Bévotte, de Girardin, Graeff, Guichard, Hébrard, Hérault, Huyot, Jacqmin, Jamin, Jourde, Lalanne, Mantion, Mascart, Ménier, Mestreau, Mouchez, Naquet, Noblemaire, Nugues, Parent, Perrier, Pittié, Planté, Proust, Raynal, de Reinach, Reymond, Alphonse de Rothschild, Gustave de Rothschild, Rouvier, Sevène, de Sourdeval, Tissandier, Turquet, Vaucorbeil, Wilson Wurtz.

Secretary—M. Georges Cochery.

Printed formulas for applications of admission may be had at the Ministry of Posts and Telegraphs, Rue de Grenelle, St. Germain 101, Paris.

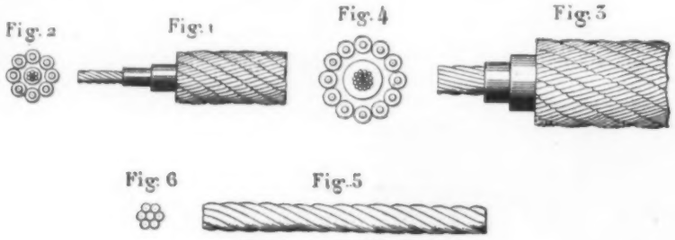
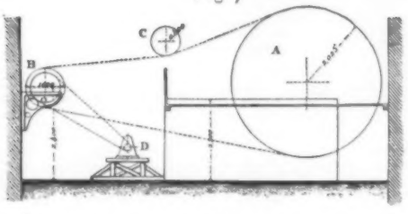
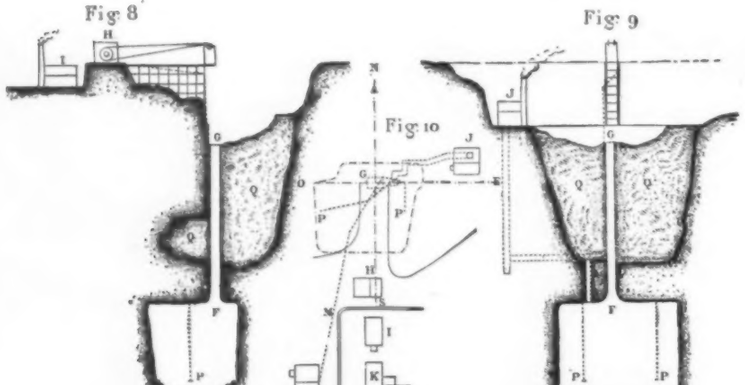


FIG. 1-6. ½ ACTUAL SIZE.





FIGS. 8, 9, AND 10 1/1000 ACTUAL SIZE.

APPLICATION OF THE ELECTRIC LIGHT AT ANGERS SLATE QUARRIES.

lamps, and a box of accessories, the whole costing, say, $800 to $900 (estimated at French prices). To this must be added the value of the electrical conductor, and which varies according to the length and section, and the value of the motor employed, which also varies according to the type adopted. The expense of the system, as employed at the Fresnais Quarry, per day of twenty-two hours, is (including interest on the amount invested) about $10, or one-tenth less than that of gas when the relative intensities of the two lights are taken into consideration. The economical advantages, then, are very great, but only on the express condition, however, that there is need, as in the above-named quarry, of a like quantity of light. For smaller works than these an expense of $10 per day for light would be inadmissible.

Figs. 1 to 6 show longitudinal and vertical sections of the different types of conductors tried, Nos. 5 and 6 being the one finally adopted as the best.

Fig. 7 shows the arrangement of the electrical apparatus. A is the driving wheel of the motor, which makes 90 revolutions per minute; B, the belts; C, tension roller; D, Gramme magneto-electric machines, having a velocity of 750 revolutions per minute.

Fig. 8, vertical north by south section of the arrangement for electrical lighting at chamber No. 10 of the Fresnais Quarry.

Fig. 9, vertical west by east section of the same.

Fig. 10—Plan.—F, chamber No. 10; G, service shaft; H, engine; I, boilers; J, entrance and drainage pump; K, gasworks; L, electrical works; M, electrical conductors; P, electric lamps; Q, filling-in from old excavations.

The principal objects to be exhibited are the following:

Apparatus for the production and transmission of electricity.

Natural and artificial magnets, compasses, apparatus for the study of electricity.

Apparatus showing the application of electricity to telegraphy, transmission, illumination, the production of light, to the service of lighthouses, signal services, mines, railroads and navigation, military sciences, arts, galvanoplastics, electro-chemistry and other chemical sciences, the production and transmission of electro-motor force, mechanics, the regulation of clocks, medicine and surgery, astronomy, meteorology, geodesy, agriculture, recording and registering instruments, and all industrial and domestic purposes.

Lightning rods; apparatus for demonstrating the first studies and applications of electricity; books and works concerning electric science and industry.

Objects admitted to the exhibition will be accepted in the Palais des Champs Elysées, on and after the 1st of July, 1881.

The boxes which contain the objects must bear the address of the exhibitor, and special labels, which will be furnished by the commissary general.

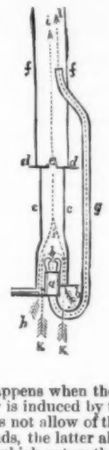
No charge for space accorded to exhibitors.

The electro motor force will be furnished at a reduced price to exhibitors. The electro-motor force will be furnished gratis during the experiments which are necessary for the labors of the International Congress of Electricians, which is to meet during the exposition.

All communications regarding the International Exhibition of Electricity must contain the necessary postage, and be addressed as follows: Au Commissaire General de l'Exposition Internationale de l'Electricité au Palais des Champs Elysées à Paris.

NEW GAS BURNER.

HERR HARTMANN gives the accompanying sketch and description of Siemens' gas burner, which Dr. Vogel hopes may be utilized for taking portraits by artificial light: A is a hollow gas burner, which does not furnish a single round flame, but rather a circle of separate pointed flames (*b*), the outlines of only two of which are given here. C is the cylinder; *d* is a sheet-iron lid having a small hole at *e*, and over which is placed a sheet-iron tube *f*, two meters or more in height, according to the height of the room. G is a tube which leads from the lower opening of the burner up into



the tube, *f*. What happens when the flame at *b* is ignited? A strong current of air is induced by the heat in the tube, *f*, and, as the hole, *e*, does not allow of the passage of so much air as the tube, *f*, demands, the latter also sucks up air by the tube, *g*. Thus the air which enters the bottom of the cylinder separates into two currents, one of which ascends in the direction, *h h i*, while the other is driven in the direction, *k k b*, into the tube, *g*. Consequently the points of the flame are bent inward and downward, and assume a clearness and whiteness which remind the spectator of the optical appearance of electric light.

THE PHARE GAS-BURNER.

THE visitor to Paris, standing with his back to the New Opera, has an opportunity of comparing the different systems of lighting three converging streets. In front is the Avenue de l'Opéra, illuminated by the electric light on the Jablochkoff system. To the right, the Rue de la Paix may be taken as the representative of ordinary gas-lighting; but the standards are placed nearer together than in London, and have each three lanterns. To the left is the Rue due Quatre Septembre, illuminated by the Compagnie Parisienne du Gaz, on the Phare system, a new method, intended to demonstrate the power of gas to hold its own against the electric light, and which was briefly noticed by us in March last. The Paris municipal authorities determined the cost of lighting a

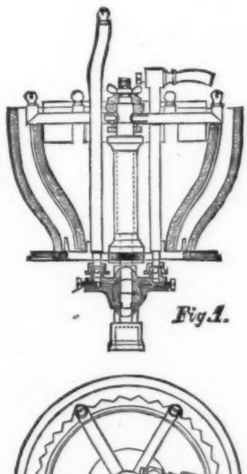


Fig. 1.

Fig. 2.

square meter of pavement by the Jablochkoff system, and invited the Compagnie Parisienne—who have the monopoly of supplying gas to the French metropolis—to produce the same effect at the same cost. The company, accordingly, placed ordinary lamp standards, raised 2½ feet on cast-iron bases, about 40 feet apart, and supplied them with their new combination of six burners, consuming together 1,400 liters (49·5 cubic feet) per hour, and giving an illuminating power of 140 standard candles. The six burners separately, consuming the same quantity of gas, would only give an illuminating power of 66 candles; and the difference is due to the increased temperature and the superior combustion, caused by the flames impinging on one another and by the currents of air directed by the glasses of the new lamp.

In the annexed engravings, Fig. 1 shows a vertical sec-

tion, and Fig. 2 a plan, of the Pnare gas-burner. Six burners are arranged equidistantly in a circle of about six inches diameter, so that the impingement upon one another of the flames causes additional and perpendicular flames between each, the whole forming a perfect and very steady *corona* of light. Annular currents of air are directed, one inside and the other outside the flame, by the two glasses, the inner one corrugated on its outside. Other currents of air, passing both inside and outside the two glasses, serve to reduce the temperature, and prevent the glasses from breaking. Altogether, it is calculated that between 400 and 500 cubic feet of air pass through the lamp in an hour. The small horizontal burner, protected by a shield, shown to the right in the engraving, is the *veilleuse*, which always remains lighted, for igniting the jets from the other burners when the gas is turned on to them, so that there is no necessity for opening the lantern. The burner on the left, rising above the others, is for use alone after midnight, when less light is required. The cock is so arranged that, on its being turned in one direction, the gas passes into the single burner, and not into the others, and on its being turned in the other direction, the gas passes into the six other burners, and not into the single one, while in the middle position gas only passes to the *veilleuse*. A rheometer is supplied below the cock for equalising the flow of gas.

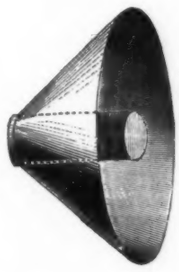
The lamps, each giving a light of 140 standard candles, are claimed to be superior in illuminating power to the Jablochkoff standards in the Avenue de l'Opéra, which are estimated as equal to only 121 candles each. The engineers of the gas company put the cost of lighting each square meter of the Rue du Quatre Septembre for six hours at 1·3 centimes, while the electric light for the same time and area costs 3 centimes.

THE CONSTRUCTION OF THE PHOTOPHONE.

IN the photophone of Professor Bell a beam of light of varying intensity is directed by a parabolic mirror upon the surface of a selenium "cell" placed in its focus, and the variations in the light, by producing corresponding alterations in the electric resistance of the selenium, affect the telephone in circuit with the cell. When the intensity of the light is varied in sympathy with the vibrations of speech the receiving telephone is made to reproduce the speech.

Now it is evident that the most powerful effects will be got from an arrangement of the selenium cell and receiving mirror which gives the widest variations of resistance for a given amount of light falling on the cell, and in a paper read before the Physical Society on Saturday last, Professor Sylvanus P. Thompson, of University College, Bristol, showed theoretically what this arrangement ought to be.

Professor Bell's typical selenium cell consists of a small cylinder about 2 in. in diameter and 2½ in. in length, presenting a superficial area of about 16 square inches, and built



up of alternate disks of conducting brass and insulating mica, with a ring of selenium filled in between the brass disks and forming a narrow border to the smaller mica disks. The alternate brass disks are connected together in multiple arc like the plates of a condenser, and a circuit is thus formed through the narrow zones of selenium on which the light is caused to fall. Professor Bell probably arrived at this form by tentative experiment, and did not stop to consider the best shape from a theoretical point of view. This, however, has been done by Professor Thompson, who was led by certain experimental results to question the perfection of Professor Bell's plan. A consideration of the law discovered by Professor W. Grylls Adams, that the change in the resistance of selenium is directly as the square root of the illuminating power, led him to the conclusion that with a given amount of incident light distributed uniformly over the surface of a selenium cell, its change of electric resistance will be proportional to its linear dimensions, provided the cell is constructed so that whatever its size the normal resistance will remain the same. That is to say, if there be a cell of a certain size and resistance (measured, for example, in the dark with a standard electromotive force), then a perfectly similar cell made on a scale *n* times greater in linear dimensions each way, will suffer *n* times as great a variation in resistance for the same total amount of light falling on its surface.

Professor Thompson further reasons that with a given amount of light the change of electric resistance in the cell will vary in proportion to the third power of the linear dimensions of the cell, provided that while its linear dimensions are increased the absolute thickness of the brass disks and the selenium rings remain the same as before, and their number is proportionately increased.

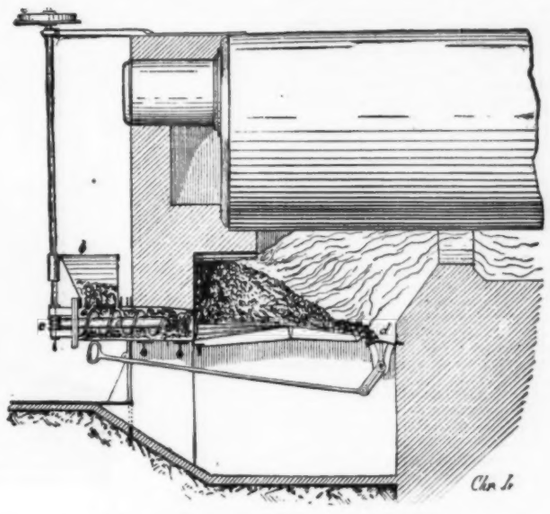
The practical deductions from these theorems is that a selenium cell for the photophone should be made as large as possible, and that the varying beam of light should be distributed uniformly over the surface of the cell and not concentrated upon one point. The parabolic mirror used by Professor Bell is therefore defective, inasmuch as it tends to focus the parallel rays to one point. Professor Thompson suggests a better substitute in a short conical mirror silvered inside and having the cell placed along its axis. Such a mirror would not only be cheaper to construct than a paraboloid, but it would not reflect away light from the selenium, as all the rays would fall perpendicularly on the surface of the latter.

With regard to its angular aperture Professor Thompson finds that the greatest number of rays would be reflected upon a cylindrical cell lying along its axis if the angle of half its aperture were 45° or 90° for the whole cone. The front end of the selenium cell might then be brought flush with the plane of the mirror mouth, as shown in the figure. With an angular aperture less than 90° the depth of the mirror from base to apex would have to be greater than the length of the cylindrical cell to give the best effect, and the mirror, however prolonged, could not bring more rays to the surface of the cylinder except they underwent more than one reflection. With an angular aperture less than 90° the diameter of the mouth would require to be less than that of the 90° cone, and hence would not collect as much light.

It is questionable, too, whether the pile of disks is the best form for a selenium cell, and professor Thompson, acting upon a hint borrowed from Mr. Shelford Bidwell, has constructed a wire cell which promises to act still better. This is made by taking a cylinder of slate and grooving a double-threaded screw round it, then laying two fine wires in the parallel grooves and filling the space between them with selenium. These cells are under test, and their behavior will be a matter of interest to those who watch the improvement of Professor Bell's beautiful apparatus.—*Engineering.*

ROBER'S AUTOMATICALLY-FED FURNACE.

MR. ROBER, of Dresden, has invented a smoke-consuming furnace, especially adapted for boilers, and which, by an ingenious arrangement, is fed automatically. The consumption of the smoke is effected by the application of the well-known principle of feeding from beneath. The cut annexed shows the apparatus in section. A helix, *a*, placed in front of the grate, and caused to rotate in a regular manner,

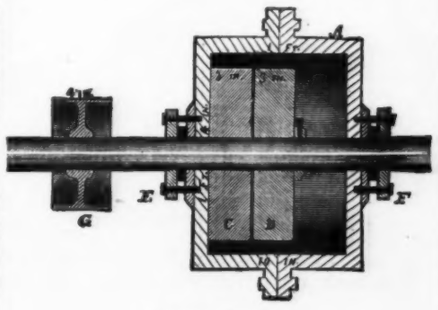


AUTOMATIC FUEL FEEDER.

pushes the combustible on to the latter. The cylinder in which the helix revolves is surmounted by a hopper, *b*, filled with coal. The helix is actuated by means of an endless screw fixed to the lower part of the axle of the driving pulley, *e*. The coal, thrust forward by the threads of the helix, enters beneath the ignited layer, and there undergoes, before burning, a sort of distillation. The gases which are produced, traversing the burning coals, are completely consumed without giving rise to any smoke. In proportion as the coal advances it pushes before it the ashes and clinkers as far as the extremity of the grate, where there is fitted a piece, *d*, which is movable, around an axis, governed by a long rod. This rod has only to be pulled back every six or eight hours to cause the clinkers to fall into the ash-pan. As for the sides of the grate, it requires a poker to clean them. For this purpose the front of the furnace is provided with two small lateral doors, through which the poker may be introduced.

A NEW HEATER.

THE following illustration will give a clear idea of the latest apparatus for heating purposes, the invention of Prof. Webster Wells, Professor of Mathematics in the Massachusetts Institute of Technology:



A NEW HEATER.

The principle of this machine is friction, and the simplicity of construction and adaptability to every place where waste power can be utilized are remarkable. It consists only of an iron cylinder, 2 feet long and 1 foot in diameter, having a fixed plate of hardened iron in one end, and a second plate, attached to a revolving shaft, which presses lightly or closely upon the fixed plate, as circumstances require. The cylinder is filled with water, the shaft revolves, and from the friction of the plates the water in an incredibly short time is heated, and by means of steam pipes can be carried to great distances for heating purposes.

The construction of the machine is such that it is easily adapted to every place where there is waste power, as in mills, factories, public buildings, and cars. In fact, in every place where any power is used the machine can be applied, since the power required for its operation is so slight as to be of almost no account. Thus, to carry a machine with 36 square inches of friction plates—the ordinary size—one-half horse power only is required; while a machine with 225 square inches of friction surface will require at most but four horse power, and will heat a room 60x200, or 126,000 cubic feet. In steam cars the machine is easily and cheaply adjusted to the axles, the power being taken directly from the wheels, so that in case of accident, such as started the train of thought which resulted in this invention, all danger from fire is entirely eliminated.

This machine has already been in practical operation for some months, and has demonstrated that with 36 inches of friction surface a room of 10,000 cubic feet can be heated more uniformly and quicker than by the use of coal, wood, or steam, and without expense save the wear of the friction plates and the cost of extra coal under the boiler.—*American Engineer.*

A NEW INSTRUMENT FOR UNDERGROUND SURVEYING.

ALTHOUGH several improvements have been made during the last few years in the construction of the theodolite and dial, and these instruments are now considered perfect for all practical purposes, there are, however, other instruments which the mining engineer and surveyor must use, and the much greater accuracy which is now necessary in making mining plans, in consequence of numerous contiguous workings, and the necessary accuracy of plans to prevent encroachment and consequent litigation, makes it desirable to use the best instruments for securing precision. One of the defects in the present system of surveying is the method of transmitting a mark from the center of the dial to the roof in the mine. The usual practice is to hold the line and

A NEW INSTRUMENT FOR UNDERGROUND SURVEYING.

plumb-bob with one hand above the instrument, and after getting the center the hand is removed to allow the mark to be made on the roof with the other hand. This method is too much dependent on guesswork, and for accurate operations, say in the case where two headings have to meet, surveyors, although it sometimes entails a large amount of ex-

tra work, prefer to go over the whole distance again rather than rely on a mark made in this way. To overcome these difficulties, Mr. W. E. Garforth, mining engineer, Normanton, has designed an arrangement of adjustable plumb-bob and holder, which we illustrate in the accompanying drawings.

From this it will be seen that Mr. Garforth's new instrument, which is very ingenious and extremely neat in design, consists of a small brass box plate—with projections to prevent slipping when placed against the roof of the mine—on the under side of which the rack, C, is arranged to move backwards and forwards the projecting arm, which can likewise be worked at right angles by the second rack, D. By means of these motions the string connected with the plumb-bob can be moved to any required position by the wheels, A and B, which, although placed on one hollow spindle, work independently of each other. At the extremity of the arm a duplex center or gimbal motion—similar to that in use for suspending a ship's compass—is arranged to hold the rod, R, through which a string passes, to which is attached the plumb-bob which causes the rod, R, to hang in a perfectly vertical line whatever the inclination of the roof of the mine. The movable slide, T, which is bored to fit the rod, R, when lifted upwards either by a spring or by hand, as preferred, is consequently obliged to move in a perpendicular line. An adjustable screw cap, in which is placed the chalk or needle, is fitted to the upper end of the slide. The plumb-bob, L, is arranged with a lock nut, H, so as to allow the string between the instrument and the roof to be lengthened or shortened as required, and to obtain greater accuracy the plumb-bob has a long adjustable coarse-threaded screw, K, to enable the point of the plumb-bob to be brought in the closest contact with the glass of the instrument.

Now, assuming it is required to transmit a mark, the "dial center" is placed against the roof of the mine, the string adjusted first by the lock nut, H, and afterwards by the screw, K, the screws, A and B, are then worked until the pumb-bob hangs exactly above the center of the dial, when the slide—which, for the reasons already explained, is caused to hang vertical—is next moved upwards, and the center mark made in the roof. To obtain even greater accuracy, and when the mark has to be made on timber, the screw, M, can be attached to the movable slide, and instead of a chalk mark a loose needle can be pressed and left in the plug or timber.

Mr. Garforth's "dial center" will, without doubt, prove a most useful adjunct to the dial, and a means of saving considerable time in setting out lines is now almost daily required, especially in those collieries where an extensive system of chain or rope haulage is at work, and where straight roads are found to work so much more advantageously, as compared with crooked roads. The plumb-bob used by itself will prove of service to architects and engineers, as there is often a loss of time in having to lengthen or shorten the line, which is so quickly adjusted by the arrangement shown.—*The Engineer.*

THE PLATTSMOUTH BRIDGE.

THE Plattsmouth bridge was begun July, 1879, and opened for traffic August 30, 1880. It was built to connect the main line of the Chicago, Burlington and Quincy Railroad with the railroad system south of the Platte River in Nebraska, known as the Burlington and Missouri River Railroad in Nebraska, and which now forms the Nebraska Division of the Chicago, Burlington and Quincy Railroad.

Location.—The proper location of this bridge was really the chief problem in its construction. The Platte flows into the Missouri about a mile above the town of Plattsmouth, and is a disturbing element which at times attains a considerable magnitude. Opposite the town of Plattsmouth the high water river is about a mile wide, and the channel very variable, having within a few years been next to the east shore, next to the west shore, and about in the middle. At low water the river is confined to the width of the channel, the remaining portion being a dry sand bar. At a point a mile below the town, where a dike had been built, this width is contracted to less than 900 feet. The contraction resembles the throat of an hour glass, being drawn in on both sides, by the bluff on the west and the dike on the east. The result of this configuration was that the channel was fixed with as great a degree of permanency as is ever found in the Missouri in its position, but the direction of the current changes greatly, according to the position of the channel in the broad river above. It was decided at once that the location of the bridge ought unquestionably to be a little below the dike, at the point where the greatest permanency of the channel had been established. The only objection to this location was the existence of a high clay bluff on the west approach involving a deep and expensive cutting.

THE PLATTSMOUTH BRIDGE—END VIEW.

The changeable direction of the current rendered the construction of a draw-bridge virtually out of the question, as it involved keeping the channel current parallel to the shore line and the draw pier, and it was decided to adopt the high-bridge plan, which has generally met with more favor than the draw-bridge plan for bridges on the Missouri.

General Description.—The line selected for the bridge crosses the river about 500 feet below the dike. The river at all ordinary stages, in fact for all stages except those of exceptional high water, is crossed with two spans of through bridge, each 400 feet long, the bottom chord of which is placed 50 feet above high water; the extreme rise and fall of the river is about 17 feet.

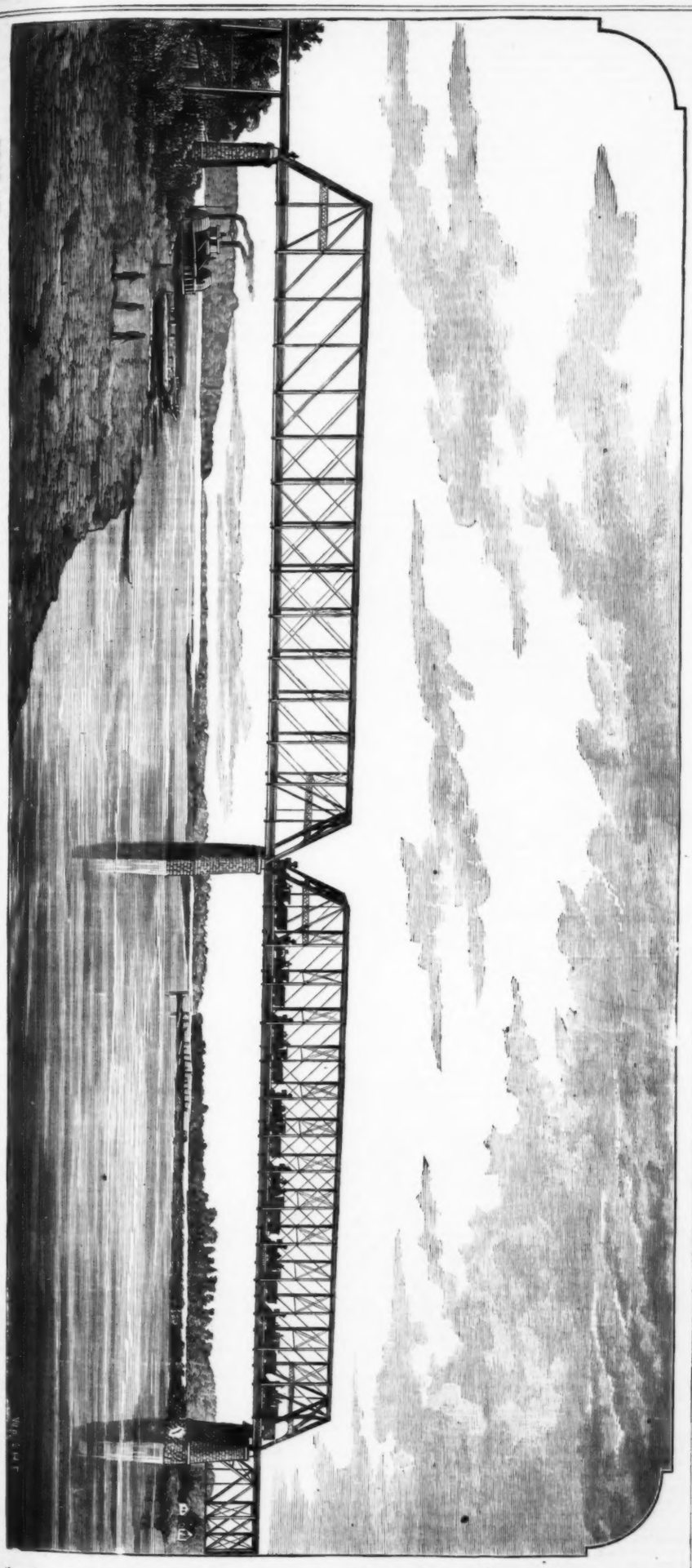
On the east side are three deck spans of 200 feet each, reaching across the sand bar, and beyond them 1,440 feet of iron viaduct. On these deck spans and viaduct there is a grade of 0·5 in 100, descending eastward. From the east end of the viaduct the grade descends on an earth embankment at the rate of 1 in 100 to the level of the Chicago, Burlington and Quincy track, on the Missouri bottom. The east approach is straight for about two miles. On the west side an iron viaduct 120 feet long reaches from the main bridge to the beginning of the approach. This west approach begins with a 12° curve to the north, the short piece of viaduct being built on a compound curve connecting with this; the approach passes through a cut nearly 80 feet deep at the deepest point, and thence along the face of a clay bluff to Plattsmouth station, its length being just one mile. The grade of the straight portions of this line is 45 feet per mile, ascending eastward, compensated for curvature, and reduced to 13 feet per mile on the 12° curve.

The bridge proper is just 3,000 feet long from outside to outside of abutments; the main structure 804 feet long from center to center of piers Nos. I. and III. The foundations of the three principal piers rest on bed-rock at depths varying from 30 to 50 feet below extreme low water. The foundation of pier No. II., the pier east of the east large pier, is also carried down to rock. Pier No. V. has a pile foundation; all other masonry, being well back from any chances of scour, is founded on concrete.

Foundations.—The foundation for pier No. I., the pier at the edge of the west shore, was put in with an open pit, the sides being protected by ordinary sheeting. An unexpected difficulty occurred at this point. Borings carefully taken

THE PLATTSMOUTH BRIDGE OVER THE MISSOURI RIVER.

BRIDGE ACROSS MISSOURI RIVER AT PLATTSMOUTH, NEB.—J. C. GOODRIDGE, JR., N. Y., ENGINEER OF THE FOUNDATIONS.



BRIDGE ACROSS MISSOURI RIVER AT PLATTSMOUTH, NEB.—J. C. GOODRIDGE, JR., N. Y., ENGINEER OF THE FOUNDATIONS.

over the whole site of the pier had found rock about low water level. The solid character of this rock had been established by drilling into it 2½ feet, and its existence was corroborated by the testimony of men engaged in the river who said they had seen it at extreme low water. When this rock was reached it was found to be really a mass of bowlders from 4 to 6 feet thick, so closely packed that the drill holes had passed from one stone to another without detecting the crevices, and many of the rocks were so large that they could only be removed by blasting. Below these bowlders was found a mass of stratified shale which had evidently never been disturbed. The excavation was carried through this shale to a depth 28 feet below low water, where a flat limestone bed-rock was reached. To render the work doubly secure against a possible slip in the shale, 190 holes 18 inches deep were drilled into this rock, in each of which a dowel of 1¼ inch iron was placed. The pit was then filled with Portland cement concrete to the low water level, and on this concrete the masonry of the pier was started. This concrete, as well as all other concrete in the deep foundations, was manufactured by Dr. J. C. Goodridge with the French mixing machine designed by M. Coignet.

The foundations for piers Nos. II. and III. were put in by the plenum pneumatic process. The caissons were 51 feet long and 21 feet wide, built of pine timber, lined with plank well calked, and sheathed on the outside with two courses of 3 inch plank, the inside course being put on diagonally. The design of these caissons differs from the form of caisson which has been hitherto used; the outer walls were built of 12x12 inch square timber, and the side walls of the working chamber, which were made of the same sized timber, inclined inward from the cutting edge. The roof was made of a single course of 12x12 inch timber, surmounted by about 8 feet of cribbing. The entire space above the roof of the working chamber was filled with concrete, the mass extending down into the V-shaped spaces in the side walls, and interlocking with the crib work in such a way that comparatively little of the weight came directly on the roof of the working chamber. The timbers of the successive courses were fastened together with drift bolts 30 inches long, and the whole caisson was bound by long iron bolts extending through the whole height of the sides, at the corners and the intersecting points of the cribbing. The reason for adopting this plan of caisson instead of the more usual plan in which a thick timber roof is used, was to secure at once the greatest possible combination of strength and weight, so as to sink the piers to the bed-rock by steady pressure instead of occasionally blowing off the compressed air, thus reducing to a minimum the risk of overstraining the work, and breaking the bond in the masonry. The success of this form of caisson was complete.

The caissons were built on shore, launched and towed into position; that for pier No. III. was built first. The pneumatic machinery was erected on the east sand bar near pier No. III., and the air and water were led to the sites of the piers in pipes. The sand was generally excavated by the use of the Eads sand pump, the water being supplied by a No. 8 Cameron pump. Before work was begun at pier No. II., a temporary bridge was built from the east shore to the site of the pier, which served for transportation of material and to carry pipes. This service bridge was built in connection with a temporary bridge used for transportation of cars.

The masonry was started a little below extreme low water; the space between the top of the caisson and the masonry is occupied by crib work made of 6x10 inch pine timber laid flat and filled with Portland cement concrete. The superior excellence of the concrete used makes these foundations probably stronger than if built of ashlar masonry.

The foundation of pier No. IV. was likewise put in by the pneumatic process, but the caisson is considerably smaller, and constructed on a much less perfect plan. The piles for the foundation of pier No. V. were driven with a 3,800 pound hammer, and have an average penetration of 28 feet; they were driven in an excavation made inside a timber curb, and are cut off about three feet below extreme low water. Pier VI. has a concrete foundation, as have also the small piers under the viaducts.

Superstructure.—The superstructure of the Plattsmouth bridge may be divided into three parts—the iron viaduct, the deck spans, and the channel spans. The general specification on which the entire superstructure was proportioned, provides for a uniform moving load of 2,000 pounds per lineal foot, preceded by two locomotives, each weighing 150,000 pounds on 50 feet, the additional 50,000 pounds of locomotive weight being supposed to be concentrated on a length of 20 feet. The structure is also designed to resist a lateral wind pressure of 500 pounds per lineal foot on the floor, and 200 pounds per lineal foot on the top chord of the through spans, and the bottom chord of the deck spans; these quantities are about equivalent to a wind pressure of 30 pounds per square foot on the bridge when covered by a train, and to 50 pounds per square foot on the empty bridge.

The three deck spans are each 200 feet long between centers of end pins, 30 feet high, and 16 feet wide between centers of chords. They are "Pratt" trusses with single intersection webs and inclined end posts, and have each eight panels of 25 feet. The floor beams rest on the top chords, and the track stringers are riveted to the webs of the floor beams. There is a grade of one-half of 1 per cent. on these spans, made by placing each span at a different elevation, the second and third being respectively 1 and 2 feet higher than the first span, and the grade in each span being made by varying the depth of the floor beams on the chords. The third span rests in recesses left at the proper elevation in the masonry of pier III. The 200 foot spans are entirely of iron, except the pins, which are steel.

The two 400 foot spans are each 400 feet long between centers of end pins, 50 feet deep, and 22 feet apart between centers of chords. They are pin-connected "Pratt" or "Whipple" trusses, with inclined end posts, the webbing arranged with double intersections. Each span has 16 panels of 25 feet. The ties are in two lengths, and couple on pins passing through the centers of the posts. Attached to these pins, a strut extends between each pair of posts, and a system of diagonal wind bracing connects these struts with the top lateral struts. The middle of each inclined end post is supported by a horizontal lattice-work strut, which reaches to the first vertical post. The floor beams are riveted to the posts immediately above the bottom chords, and act also as lateral struts, the lateral ties being coupled on pins, passing through jaw-nuts, screwed on the ends of the lower chord pins. The stringers are riveted to the webs of the floor-beams.

In these trusses, the top and bottom chords, inclined end-posts, main and counter ties, lateral rods, pedestals, rollers, and all chord and lateral pins are of steel. The intermediate posts, end suspenders, lateral struts, portals, stringers, and floor-beams are of iron.

Floor.—The floor of the Plattsmouth bridge is uniform from one end of the permanent structure to the other. It is so designed that it is believed it could safely carry a derailed train for any distance.

The iron stringers are placed 9 feet from center to center. On these stringers rest oak ties 9 inches square and generally 12 feet long, these ties being only 6 inches apart in the clear. The ties are held in place by two oak guard timbers or ribbons, these timbers being 10 inches square and sized down 1 inch over each tie; the guards are 10 feet 4 inches apart in the clear, and fastened with a 1 inch bolt to every fourth tie. Inside the rails are placed two lines of 4x5 inch angle iron, with the long side flat laid to a gauge of 3 feet 8 inches over all, and bolted to every tie with a 1 inch bolt; this arrangement leaves a space of 6¼ inches between the angles

and the rail which is wide enough for a derailed wheel to travel in. The nuts are on the upper ends of all the bolts so that they can readily be tightened by the bridge watchman.

Every fourth tie is 16 feet long, projecting 2 feet on the outside of the ribbons, and on these projecting ends is laid a foot walk composed of two lines of 2×10 inch oak plank. Every twentieth tie is 18 feet long, projecting 1 foot on each side of the footway, and carries a wrought iron stanchion through an eye, at the top of which is passed a ¾ inch wire rope which serves as a hand rail.

At the west end of the bridge, where the short piece of viaduct is on a sharp curve, the ties are 9×12 inches, and sized to give a slight elevation to the outer rail.

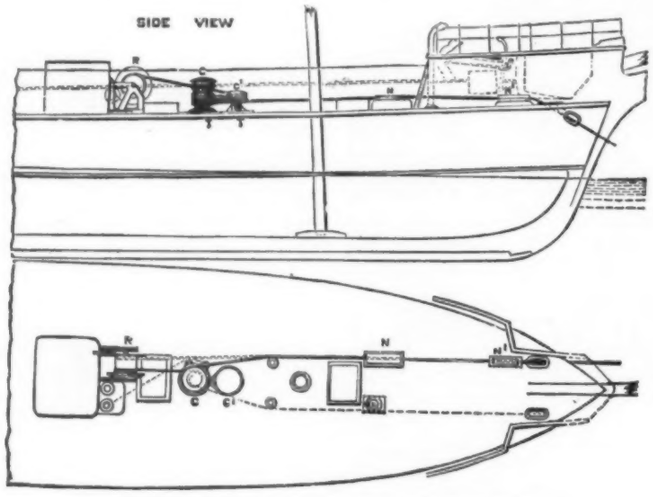
Ties of the same dimension as those on the bridge are laid across the masonry of the abutment, and on these the ends of the guard angles are brought together in a point in the center of the track by pieces of 4 inch oak plank cut to shape, bolted to the ties and plated on the face with a wrought iron strap.

Engineering Staff.—Chief Engineer, George S. Morison; first assistant Engineer (stationed at Plattsmouth), Henry W. Parkhurst; assistants, Benjamin L. Crosby, W. G. Dilworth; draughtsman, S. W. Y. Schimonsky; assistant Engineer of Superstructure, C. C. Schneider; inspectors, Jacob Jung, A. Lavandeyra.

The principal contractors engaged in this work were the following: Masonry, Reynolds, Saulpaugh & Co.; concrete, J. C. Goodridge, Jr., New York; pneumatic foundation works, W. Sooy Smith; superstructure of 400 foot spans, Keystone Bridge Co., foreman of erection, W. Baird; Viaduct and 200 foot spans, Kellogg & Maurice, foreman of erection, J. B. Ryland; grading of approaches, N. S. Young, Burlington, Iowa; enlargement of west approach and filling temporary trestle in east approach (this work not yet completed), S. Dwight Eaton, Burlington, Iowa.—*Railway Review.*

WIRE CABLE GEAR.—S.S. MOEWE.

APPLICATION was made a few months ago to the Committee of Lloyd's Register of British and Foreign Shipping to sanction the use of flexible steel wire cables with the necessary appliances in lieu of chain cables for ships classed in their books; this application was favorably received, and in June this year the committee sanctioned the use of one steel wire cable for steam vessels. The Board of Trade is also willing, we understand, to pass steam vessels fitted with



WIRE CABLE GEAR.—S.S. MOEWE.

these appliances; and the Admiralty has had them in actual operation on board of the Valorous for six and a half years, and also on board the Eclipse.

Before referring to the illustrations we may state briefly that the chief advantage claimed for the use of wire cable in substitution of the ordinary chain cable is uniformity of strength. A chain cable may have, and too frequently does have, defective welds, but a wire cable of large size is composed of no less than 180 threads, and these must most completely "break joint" over each other should any accidental defect exist in the wires. There is also an important saving in weight. If, for example, the City of Rome, now building at Barrow, were fitted with chain cable, the thickness of metal in each link would probably be about 2½ in., weighing at least 256 lb. per fathom; while, on the other hand, steel wire cable need only weigh 47 lb. per fathom to be of equal if not superior strength, thus saving more than 200 lb. per fathom used, or about 28 tons altogether. It is true that the weight of the chain cable largely assists the anchor in holding the vessel, but weight so disposed cannot be considered to be as economically arranged as is the case with a comparatively light cable of wire attached to a suitable anchor of increased dimensions, and the greater facility of handling the wire cable must be of importance, especially as regards the time necessary to weigh anchor.

There is said to be practically no noise in working the wire cable, and it is usually coiled upon a reel stowed on deck in what would be otherwise waste space; thus avoiding the stowage in chain lockers in the forward part of the ship of a weight of chain which no doubt tends greatly to strain the vessel at that unsupported part. Wire cable in addition to being used in the vessels above named has also been in satisfactory operation on board some of the Channel steamers, and is now being fitted to the Imperial German gunboat Moewe, as well as to merchant ships. We annex illustrations showing the appliances for working it which are being fitted to the Moewe. The wire rope is fitted on the port side, and consists of 150 fathoms of 5 in. rope in one continuous length, weighing 281½ cwt., with a breaking strain of 65 tons. A chain cable is fitted on the starboard side, and is stowed in the usual way by leading it into chain lockers in the hold; the lower part of the capstan is used for this cable only, while the upper part and a sister capstan, placed just the fore-side of it, work the wire rope cable, which is passed round them in grooves in the form of a figure 8; this avoids nipping, as the rope leads on to the lowest ring of the main capstan and leads off the top ring of the sister capstan, and in order that the rope may not chafe the grooves are set some distance apart. The wire cable is stowed on a reel conveniently placed abaft the capstans on the same deck. Automatically holding nippers secure the wire cable by friction while the ship is anchored, one being placed where the port riding bit for working chain formerly stood, and the other in the eyes of the ship. When the anchor is let go the wire cable runs straight from the reel to the nippers and through the hawse holes without being passed round the capstans.

The gear is made and fitted on board ship from the designs of the makers, Messrs. Bullivant & Co., of Millwall and Mark lane; and we understand that on each trial the working of the apparatus has been so entirely satisfactory as to warrant the conviction that the use of flexible steel wire cable and apparatus will become very general.—*The Engineer.*

[AMERICAN NATURALIST.]

ZOOLOGICAL NOTES.

Habits of the English Sparrows in the United States.—The severe handling which that little immigrant, the English sparrow (*Passer domesticus*), has of late received on all sides in the United States, and especially from our men of science, has sometimes made me feel disposed to consider the little fellow overabused, and has tempted me to say a word in his favor. But, as even his enemies acknowledge, he is more to be feared than despised, and as he has also not been without his advocates, I have hitherto refrained from interfering, and have remained a silent looker on.

One day in the early part of the month of January, 1880, during a high wind, a bird house occupied by birds of this species, and attached to a tree growing in the grounds connected with one of our public institutions, was brought to the ground by the giving way of a decayed branch. I was surprised to find it completely filled with a mass of rubbish consisting of dried grass, straw, weeds of various sorts (principally amaranthus and chenopodium), horse hair, thread, rags, paper, and feathers. The entire arrangement forbid the supposition that it was intended for nesting purposes, and an examination of the other sparrow-houses in the extensive grounds established the fact that they were similarly furnished. It was clearly a provision on the part of the bird against the cold of our severe winters. The gardener who looked at it in the same light, informed me that he had to clean out this rubbish from the houses every spring at nesting time, and that it was not their nests, which are altogether different. This is exceedingly interesting, as pointing to the capacity for self-improvement in the species. I have failed to find any description of such a habit in the English sparrow, and it would seem to have been acquired since its advent to our shores; though it would be important to know whether it adopts this precaution against the cold in the more northern countries of Europe.

A short time before the above-mentioned occurrence, one of those birds, in the same grounds, was noticed as being sick. Several of the other sparrows waited most assiduously upon it, with affectionate care, and kept it supplied with food which they continually brought it. During the night a "cold snap" set in, and the next morning the sick bird was seen, perched on a railing, its companions hovering over it with evident anxiety, and bringing food which they tried to make it eat. On going up to the bird, it was found to be dead and frozen stiff. This incident exhibits the species in a very different light from that in which it is usually represented by its American biographers.

But now comes the other side of the picture. In the following April, at the blossoming of the peach, which this year was unusually early, I saw, one morning, two English sparrows busily at work on a peach-tree in my yard, and, on going nearer, perceived they were nipping off the blossoms with terrible rapidity. The ground was already strewn with scores of the crimson flowers, and I have no doubt that unless interrupted, the tree, which is of a fair size, would have been utterly stripped—to the last bud, within less than half an hour. Close watching failed to discover the object of the birds, whether they were in search of insect or vegetable food, or whether their action was an exhibition of mere wantonness or destructiveness, which latter conclusion it would be difficult to receive. On the following morning another of the species was found similarly employed on a neighboring peach-tree, which was being just as rapidly denuded of its blossoms. The flowers were nipped off by the bird's beak, at the peduncle, a short distance below the receptacle, as neatly and swiftly as though done with a pair of scissors. This opened to my gaze such a horrible vista as to the destructiveness of the bird, that I turned away aghast at the spectacle. At this rate a few pairs of this sparrow would destroy the crop of an entire peach orchard in the course of two or three days. It cannot be, however, that this is a general habit of the bird, as our peach crop this season was the most abundant which we have had for years; fine peaches being retailed here, early in the season, at as low as three cents per quart.

Considering the destruction wrought by insect pests in our Southern States, I have thought this sparrow would prove of great benefit to that region, saving millions of dollars in the cotton, corn, vegetable, and tobacco crops. The climate would also seem to be more suitable for it, particularly during the winter.—*Henry Gillman, Detroit, Michigan.*

Intelligence in a Cat.—The chief of our pets is "Shorty," a castrated cat now fourteen years old. Of course he has led a very quiet, dignified life, always at home, and never addicted to roof music at nights. He is a dear old fellow—neat and tidy in his habits, and taking the presence of any kind of filth as a matter of deep disgust and offense. In his middle age—avoirdupois sixteen pounds—he was a "mighty hunter"—his greatest recorded feat being the killing of nine rats in one pleasant afternoon. It is an abomination in his ears to have them pierced by the "discordant noises" of a cat fight. One day, years ago, two younger felines engaged in an animated discussion with claws and teeth, filling the air with yells and flying fur. "Shorty" heard it, and ran in a succession of flying leaps to the spot. He bounded in between the two "bad boys," separating them in an instant. There he stood for a brief space, eying first one and then the other, with his right paw elevated, and growling fiercely. The youngsters drew down their arched backs, the bristling tails collapsed, and they left the spot, each in a different direction, at the command of the peace maker. He once "brought up" a motherless kitten. At first, he was highly indignant at the presence of the little one, but finally took charge of it most kindly and tenderly, allowing it to suck his rudimentary teats. He afterwards weaned it, and then hunted for it, precisely as a "mother kitty" would have done! "Shorty" seems always *sensible* of the fact, if any of the family are ill or feeling blue or discouraged; in such cases he springs into one's lap and purrs his loudest, *looking* his sympathy most unmistakably, as much as to say, "Don't feel badly—don't be discouraged!" On one occasion a lady of the family, while suffering from a severe attack of toothache, burst into tears. "Shorty," who was regarding her intently, sprang upon her lap, and placing a paw on each side of her neck, looked into her face, giving utterance to frequent and piteous mews. That his friend was suffering grievously he *knew* as well as anybody, and he manifested his sympathy and regret in quite as decided a manner. Many anecdotes of the old fellow are treasured up in the legends of the family, but the above are probably as characteristic as any. He is now in the "sere and yellow leaf," being afflicted with "rheumatics" when the weather is heavy, and having lost his under tushes, but we cherish him for the good he has done, and for the kindly sympathy he has always manifested for his friends.—*Chas. Aldrich, Webster City, Iowa,* 1880.

Curious Habit of a Dragon Fly.—One day this summer, when I was looking at some tadpoles in a dish of water, I was struck in the face by a jet of water. On searching for the cause, I found that the larva of a dragon fly (Æschna) was my assailant. When disturbed it sent out a fine stream of water from the branchial apparatus in the caudal end of its body to the distance of two or three feet, and not content with one volley, it would wheel and discharge, like a small gun, at all points of the compass. I put it in a tumbler of water, and it lowered the front of the body, and shot the water far over the edge of the glass. I cannot say it ever took deliberate aim, but I know I got sprinkled many times when I inadvertently touched the glass.

Prof. Packard, in writing of the larval dragon-fly, says: "By a syringe-like apparatus lodged in the end of the body, it discharges a stream of water for a distance of two or three inches behind it, thus propelling the insect forward. The apparatus combines the functions of locomotion and respiration." ("Guide to the Study of Insects," p. 601.)

If all Æschnæ have the same habits as the one I caught, we must add that the apparatus is also a means of defense.—*Sarah P. Monks.*

Migrations of the Sand-Hill Crane.—I had to-day a fine opportunity to watch the migrations of the sand-hill crane, and observe their method of managing their flight under adverse circumstances, that is, with a strong wind in the rear. They were flying at great height, and during two hours several hundred passed over, going toward the south-west, the wind at the time being nearly due north and blowing quite hard. They would proceed in the ordinary manner for a short time, and then when the wind apparently became too strong for them, would wheel round and face it, and allow themselves to be carried along by it in the same way that a fish sometimes lets himself be carried down a rapid current, tail foremost, by simply putting forth just strength enough to keep his head up stream. When the wind slackened they would again wheel and pursue their way, to repeat the same maneuver a little further on. This might seem to be a very slow mode of traveling, but after watching a number of flocks I concluded that their rate of translation could not be much less than that of an ordinary railway train.—*F. E. L. Bent.*

THE MECHANICS OF BIRD FLIGHT.

THE mechanics of the flight of birds have been much studied, and considerable space has been recently given to the subject in the columns of the *English Mechanic.* A new contribution has been recently made to a Silesian society by MM. Legal and Reichel, whose researches deal with the relations of the size of the muscles of flight, and the size and form of a wing surface, to the power of flight, and a short account may be of interest. (An abstract of the authors' observations appears in a recent number of *Naturforscher.*)

The authors begin by considering the question, Whether the absolute size of a bird is of importance with regard to its flying power, *i. e.*, whether two birds, which considerably differ in size from each other, but are geometrically similar in their whole bodily structure, fly equally well? The final answer to this is (as we shall see) a distinct negative. The authors have measured in a great number of birds the weight of the muscles of flight, especially the most important of these, the great breast muscle, as also its antagonist, the wing-raising *musculus subelavius*, and compared it with the body weight. The ratio of weight of the right and left large breast muscle to the body weight varied in the different bird species that were examined, from 1:3·4 in the pigeon to 1:10·5 in the gull. But if the bird species are arranged according to the amount of this quotient, neither the equally good fliers come together, nor birds of equal absolute size; *e. g.*, the partridge stands pretty well forward in the series with 1 4·8, near and before the hawk, 1:5; while the sparrow,

stork, and eagle stand with about 1:6 near one another. Certainly, with increasing body weight, the muscular system concerned in flight does not become relatively greater. The size of the muscles of flight is only one factor in flying power.

A second and very important factor is the surface presented by the outspread wing (the wing surface); and here, again, it is not immaterial in which direction the surface extends. With equal wing surface, a long, narrow surface has more effect than a short and broad one, as a long rudder is more powerful than a short one. The authors have, therefore, given drawings of the form of the outspread wings for thirty-seven different bird species, and indicated in figures the surface and length (wing configuration). A calculation of the mechanical action showed that where the ratio of the surface and length of the wing to the size of the bird remained the same, the angle of the wing motion and the angular velocity of the wing also remain the same; also that with the absolute size of the bird the air-resistance against the wings increases in the fourth power, but the body weight only in the third. In order to compare the significance of wing configuration for flight in large and small birds, one must, therefore, introduce into the numbers, expressing wing configuration, a correction according to the absolute size of the bird, and the result of this correction the authors name the wing number. Now, if the various birds be arranged in series according to wing number, *i. e.*, according to wing configuration, with comparative preference of the smaller, the good fliers are found to be at one end of the series, the bad at the other, *e. g.*, partridge 4, wild duck 10, jackdaw 20, sparrow hawk 24, sea swallow 50. If we now multiply this wing number with the ratio of the weight of the breast muscle to the body weight, *i. e.*, combine the consideration of the actual wing configuration with that of the relative size of the muscles of flight, which are related to the effectiveness and velocity of wing beat, we obtain the flight number as measure of the flying power, and this appears, *e. g.*, as follows: Sparrow 0·43, partridge 0·48, wild duck 0·98, jackdaw 1·72, gull 2·15, kibits 2·92, eagle 2·95, stork 2·97, sea swallow 3·28.

A comparison of the series thus obtained with the actual flying power shows that the flight number in general rises and falls with the flying power, and, in particular, corresponds the better where birds of equal body size are considered; and less well the more different the size of the birds compared, so that in larger birds the actual flying power falls behind the comparative flight number; that even appears, *e. g.*, from a comparison of the partridge with the sparrow. Or conversely, when we compare birds of equal flying power, but different size, *e. g.*, larger and smaller, but adult examples of a species, or species of a genus, the flight number increases with the body size. It is, indeed, difficult, and always somewhat erroneous, to measure the actual flying powers of different birds together; one bird accomplishes more in dexterous and quick movements, another in rapid flight in a short time, a third in duration of flight. Still, the result may in general (says the reporter) be regarded as correct. Now, as the flight numbers express the combined mechanically measurable factors of flight, it follows that, with the absolute size of the bird, some flight-hindering element not yet therein contained increases. We might, therefore, put the question, whether equally rapid, and (comparatively) equally great, contraction in a small bird. In fact, too, it is chiefly the larger birds that present the phenomenon of soaring, a condition in which, the body being maintained at the same height for a certain time, muscular work is saved by special arrangements. If soaring be an advantage, it must, in alternation with periods of active rise by means of rudder-like mechanism, be extensively utilized for the problem of a flying machine.

THE GORILLA.

OF all the members of the monkey family the gorilla is by far the most interesting, and this great interest taken in him can be safely attributed to the meager information we have in regard to his person and habits. Gorilla hunting is a most dangerous and difficult undertaking, and but few Europeans can boast of having killed one of these monsters. H. Von Koppenfels, at present in Eliva Comi on the Gaboon, in South Africa, killed his first gorilla, a male of enormous size, in December 1874, and since that time has spent the greater part of his time in hunting, and at the same time studying the habits and peculiarities of these animals. The following extract from a letter by Mr. Koppenfels will no doubt be interesting to our readers:

THE GORILLA.

The gorillas, who had absented themselves from this neighborhood, returned to the Eliva Comi in small troops, and soon I was notified that a large family were roaming in our neighborhood. I immediately went in search of them, and after wandering about for a considerable time near the only plantation on this side of the Eliva (a lake) I was about to return to the negro village Suigamburi to stay overnight, when I suddenly heard a banana tree being broken at the end of a fenced orchard, and I was sure that a gorilla was busy there. Although it was too dark for me to discern objects sufficiently to be able to fire at them, I stopped and managed to get quite close to the inclosure, but before I could get near enough for a sure shot one of the animals gave the danger signal and came toward me screeching fearfully, whereas the others clambered over the fence of about the height of a man with great agility.

Although the gorilla approached in sudden starts I advanced looking squarely at him. I had already poised my double barreled rifle through the bushes, when the gorilla, with evident signs of great fright, turned and fled screeching fearfully. In the moment he appeared at the top of the fence to jump down on the outside. I fired, and the animal fell back into the plantation, roaring infernally. It lay there for some time and then turned to the side, and I could have dispatched it with a second bullet. The heavy ball fired at so short a distance must have wounded the animal to such an extent that it could impossibly escape. Upon hearing the shot and the roaring of the animal my companions appeared.

The wounded animal raised itself slowly without uttering a sound, and crept into the adjoining casseve bushes. I retreated noiselessly and instructed my companions to remain quiet so as not to disturb the animal. In the meantime night had overtaken us, and we returned to the neighboring settlement, and before creeping into my mosquito net I gave orders to awaken me early the next morning. I could not sleep for a long time. It was broad daylight when one of the servants called me. While dressing myself I heard a shot in the neighborhood of the plantation, and another immediately after it. I rushed in that direction and heard a few more shots.

The negroes attacked the wounded gorilla at early dawn and fairly bombarded him. As the numerous wounds causes the flesh to rot very rapidly, and the hide cannot be prepared very well, the rashness of my negroes displeased me very much, and I did not hesitate to let them understand this. As I measured the body I found the skin loosened at those places not covered with hair, and upon ripping the skin found water and air collected, a sign that decomposition had already set in. I never noticed anything of the kind before, and in future I will kill the wounded animals immediately by a second ball.

The reader will now understand why only a few museums possess stuffed gorillas. The above mentioned animal measured as follows: height 5 feet 3 inches, width of shoulders, 2 feet 2 inches, circumference of the belly 4 feet 5 inches.

A RARE COLEOPTEROUS INSECT.

AT a recent meeting of the Arthrozoic Club of San Francisco, L. Edgar Ricksecker read a paper describing a very rare specimen of coleopterous insect. He said: I have the pleasure of exhibiting to you to-night a specimen of great rarity and exquisite beauty. It is the coleopteran, *Plusiotis gloriosa*, Lec., which was procured for me lately by a friend traveling through the mineral regions of Arizona. The genus *Plusiotis* belongs, according to Dr. Le Conte's classification, to the *Scarabæidæ pleurosticti*, which is the third division of the family *Scarabæidæ*. It is purely American, five of its seven described species being found in Mexico, one in Chili, and this one in Arizona, and possibly as far west as San Diego, Cal.

It is nearly allied to the genus *Pelidnota*, of which the common grapevine beetle, *Pelidnota punctata*, Linn., of the Atlantic States, is the well-known representative; and in the same group with *Pelidnota* and *Plusiotis* is the genus *Cotalpa*, to which belongs the familiar *Cotalpa lanigera*, of a golden yellow color, and the hairy *Cotalpa granicollis*, the latter being found in Utah and as far north as eastern Washington Territory, possibly also in California.

All the species of this group are handsome insects; but this one, with its broad stripes and margins of polished gold, not only outshines all its near relations, but, in the language of Dr. Le Conte, "is the most beautiful coleopterous insect known." Many tropical species are more grotesque in form, more conspicuous in size, more gaudy in color, but in its exquisite neatness and brilliancy, *Plusiotis gloriosa* is not surpassed by any.

In size this specimen is 27 mm. (or a little more than an inch) in length, and 14 mm. in breadth. Its form is more elongate and more convex than either *Cotalpa* or *Pelidnota*. The antennæ are ten-jointed; the legs strong and massive, with the tarsal claws—like all the species of this tribe—of unequal lengths. The color above is a delicate, pale green. The thorax has a smooth, shining appearance, but under the lens shows fine, shallow punctures; its narrow, reflexed margin is banded by a continuous fillet of gold ½ mm. in width. The head is of the same green color, rather rougher than the thorax. The eye large and black, with the occipital band of dull gold color connecting them. The elytra are striated with three broad striæ on each elytron, and a narrower, more imperfect one near the outer margin, each of these being rendered conspicuous by a smooth lining of pure, burnished gold. On the ridges between the striæ are rows of fine punctures and specks of gold. Near the outer margins are two rows of fine punctures, and the margin itself is moderately reflexed and banded with gold. On each shoulder is a minute black dot. Beneath, the head and thorax are of a brilliant gold color, running to green in the middle of the body. The legs and abdominal rings are green, banded with gold. All the under parts are more or less fringed with fine white hairs.

Of the life history of this insect nothing is known; but we may well infer that it is similar to that of *Pelidnota* and other species of this group. They are leaf eaters. The larvæ subsist on decayed wood and vegetable matter, often remaining in the soil for several years before undergoing their final metamorphosis. *Pelidnota* lives on the grapevine; *Cotalpa*, if I remember correctly, on the willow; *Plusiotis* is so rare that I doubt if its favorite food plant has ever been observed. The person from whom this specimen was obtained informed me that but three had ever been found in that neighborhood. However, as this was at an altitude of perhaps 4,000 feet above the sea, I doubt whether that particular locality can be considered as a part of its regular habitat. I think the valley of the Gila River is its most natural home. Here, under the all-pervading influence of a blazing, almost tropical sun, reared in the rich, metal-

liferous soil for which Southern Arizona is famous, is brought forth the golden luster of this superb beetle.

Many species of the sub-family show a strong tendency to take on metallic hues. In this instance the combined influences of the intense solar heat, and the auriferous and argentiferous nature of the soil in which the larva digs and delves for its food, seems to augment this tendency to such a degree as to produce the brilliant result which we see in *Plusiotis gloriosa*.

THE MATERIALISTIC ORIGIN OF THE SEXES.

By ANDREW DEWAR, Author of "Origin of Creation."

MATERIALISM is yet in its infancy. Born of human learning, weaned in scientific research, and cradled in the toleration of an enlightened civilization, its advent marks an epoch in the history of humanity. Should there be fearful shadows in its progress, where loiter grim doubts and gloomy forebodings, these are only consequent to its youth, and the necessary result of the light from a sun whose slanting rays only reach us. But even as the noonday sun chases away the shadows in its splendor, so we are assured that no doctrine in these enlightened days will ever be accepted which does not in its maturity shine on the human race for true knowledge and good.

"All knowledge is our province," said Bacon, and we would be less than men if any phenomenon in nature was considered inscrutable by us, the highest outcome of Nature. Thinking thus, one of the most curious problems is that of the sexes; and the value of the doctrine of materialism is apparent when we come to question its cause, for no natural law professes even to offer an hypothesis on the subject.

It may here be asked, What is the doctrine of materialism? As enunciated by the most advanced physicists, it is that "Matter contains within itself the promise and potency of every form and quality of life." This, it will be correctly said, is only a statement, not a *cause*—an assumption that requires proof, not a proposition of fact which may be demonstrated with the facility of a problem in Euclid. Granted; but it will be admitted that if we can show how the sexes originate from matter and its inherent properties, materialism must be more than an assertion. This without further introduction we now propose to discuss.

Taking matter and its properties as the only foundation we can build on with safety, we ask, What is Matter?

After long years of experiment and failure we answer this question with a firm assurance in several things:

First. The indestructibility of matter. This involves both the eternity of matter and the eternity of the properties of matter. Nothing exists outside of matter. Nothing but matter and its properties exist. Nothing can be taken from matter, nothing can be added to it. Whatever properties matter may have had, matter must have now; and, *vice versa*, whatever properties matter has now, matter has always had.

Secondly. Matter is composed of elements of which sixty-four are known. Everything consists of those elements, their combinations, changes, and properties. Whatever form they take now, under similar circumstances they would either in the past or future also assume.

This is the foundation of materialism, and so far as it goes is perfectly clear and logical. Presuming that no force exists outside of matter, the *properties of matter* must account for every phenomenon in matter, and should they fail the premises fail also, and the fact is made certain that a force exists outside of matter, and ergo that materialism is dead.

What, then, are the properties of matter?

Here there is confusion and disagreement. Gravitation, cohesion, and chemical attraction are the three forces which have been popularly supposed to control matter; but when Huxley pertinently asked what these forces were, he found them not forces at all, but mere names or effects of a cause or causes unknown. Even evolution, from which so much was expected and preached, has fallen into disgrace, and proved to be no force or cause either, but merely an "orderly sequence of phenomena" from some cause or causes unknown. How are we, then, to discover those unknown causes? If materialism is true, they must exist; but materialism cannot be maintained as a doctrine until we show that they do exist and what they are.

We are thus led back to our premises again—to matter and the elements—and we say, according to materialistic doctrine, if sex exists in matter now, sex must always have existed. Consequently, if matter was once a sheer chaos, or, as the most daring of physicists assert, a universal fire-mist, then sex in some form or another existed in that chaos or in that mist. As, assuredly, it did not exist in the form of any kind of life we are acquainted with, we are led to ask *if matter does not contain within itself some inherent sexual or dual qualities.* If it does, materialism is alive; if not, materialism is dead.

Matter is composed of sixty-four elements, more or less. Are these elements all alike in kind, or can we trace a sex or duality in them? Fortunately for our doctrine we can. Although stated by eminent chemists to be of no importance, and made "solely for the sake of simplicity," the elements have long been divided into metallic and non-metallic classes. All the elements belong either to one class or the other. So far success seems to favor us. Doubt is the mainspring of progress, and this doubting of a fact which has long been maintained to be of *no importance* may be the key to open up unknown vistas of research.

It will, however, be conceded in a matter of no importance that this dual classification may be incorrect. This we believe to be the case, for one very important element—hydrogen—is given in every classification among the non-metallic elements, while the element itself is admitted to be metallic; a strange and incomprehensible misplacement. Whether the others are right or not only extensive experiments will determine. With this rectification, however, they are so far correct that the movements of Nature are opened to us as by a miracle. The lock cleared of this obstruction opens readily to the key and materialism rules triumphant. We seem premature; how does the duality of the elements solve all mysteries?

The object of this paper was to prove the materialistic origin of the sexes—that sex had its origin in matter. That matter is dual is part confirmation of it, but, like its antitype, we must also prove dual matter to be productive. Two females will not produce, neither will two males. If a production can be formed from the non-metallic elements only, or metallic only, then our theory is false; production should only ensue from the connection or interaction of opposite sexes and elements. Chemical analysis in this particular shows that we are right. *No natural production can be found containing the elements of only one class;* both metallic and non metallic are essential to a formation. In simple laboratory experiments the opposite elements will combine readily with one another, while combination cannot be produced among the elements of either class alone. Even the simplest natural productions, such as air and water, are of dual combinations. Air composed of oxygen, nitrogen, carbonic acid gas, *hydrogen*, etc. Water, composed of oxygen and *hydrogen*, is the great medium also of life and production. Even the old *element*, fire or combustion, can only be produced from oxygen and *hydrogen*, with other opposing dual elements. All rock formations, crystals, strata, are produced from combinations of the dual elements. All plants and vegetation are of dual formation and dual in sex, while all animals are undoubtedly male and female.

Our premises being thus clear and true regarding the elements of matter, it follows that—as all plants and animals are composed of the same elements, of oxygen, hydrogen, etc., in different proportions and combinations—the conclusion we have been seeking is inevitable, namely, *sex in either animal or vegetable life is derived from and had its origin in the duality of matter.*

What causes dual matter to combine and be productive would lead us into another inquiry as to the origin of life from matter; but this we reserve for future consideration.—*Journal of Science.*

CHICKEN CHOLERA.*

By M. L. PASTEUR.

IN the communication which I had the honor of presenting to the Academy, in the month of February last, I announced, among other results, that chicken cholera originates in a microscopical parasite; that there is an attenuated virus of this disease, and that one or more inoculations of this attenuated virus may preserve chickens from death when inoculated with the virus of maximum virulence. On account of the striking similarity that these two forms of virus present with the effects of variola and vaccine in man, it becomes interesting to ascertain not only if the immunity from the more aggravated form of virus is absolute, for the regions of the body which have undergone the preventive inoculation, but also if this immunity exists in the system, no matter what portion of the animal may have been inoculated, and what may have been the manner of introducing the virus.†

To explain with brevity the results which I have to communicate, I may be allowed to use the word *vaccinate*, to express the act of inoculating a chicken with the attenuated virus. This being admitted, I may state, as the result of many experiments, that the effects of vaccination are very variable. Some chickens are little affected by the most virulent virus after one inoculation of the attenuated virus; others require two such inoculations, and even three. In every case, the preventive inoculation does some good, because it acts in a certain measure. Vaccination, then, may be of several degrees; but we may always succeed in completely vaccinating a chicken, which means that we can bring it to such a condition that it becomes incapable of being affected by the most virulent virus.

To make this matter clear, I will now give the results of experiments: I take eighty new chickens (I call *new* those which never suffered before with chicken cholera). On twenty of these I inoculate the most virulent virus—and they all die. Of the sixty that remain, I take another lot of twenty, and I inoculate them with that quantity of the most attenuated virus which the point of the needle will take up‡—and not one dies. Are they then vaccinated for the aggravated form of virus? Some are and some are not, for if I afterward inoculate these twenty chickens with the most virulent virus, six or eight of them will not die, although they may be ill, while in the first case every inoculated chicken died. I take again from the remaining chickens another lot of twenty, and these are vaccinated with the attenuated virus exactly as the preceding lot, and, a week afterward, they are again vaccinated in the same manner. Are they now safe from the virulent virus? We now inoculate these twenty chickens with this virulent virus, and, instead of there being six or eight which do not die, there are twelve or fifteen. Finally, I take the twenty remaining chickens, and vaccinate them successively three or four times. If now I come to inoculate them with the most virulent virus, not one will die. In this case chickens are brought to the condition of animals who are incapable of suffering from chicken cholera.

As to the cause of non-recidivation, I find it impossible to resist the idea that the microscopic germ, which causes the disease, finds in the body of the animal conditions suitable to its development, and that to satisfy the necessities of its life, the germ alters certain substances or destroys them, which comes to the same thing, whether it assimilates them, or whether it consumes them with oxygen borrowed from the blood.

When complete immunity has been reached, the most virulent germ may be inoculated into any of the muscles without producing any effect. This means that the cultivation of the germ has become impossible in these muscles. They no longer contain food for the germ.

It is impossible to convey the impression that one receives from observing such phenomena. Here are twenty chickens which never had this disease. I inoculate them in their pectoral muscles, or, still better, in the muscle of the thigh, so as to observe with greater ease the effect of the inoculation. The next day all the chickens are lying down; they are very lame, and seem overcome by sleep. The inoculated muscle becomes of enormous size, and is profusely filled with the parasites. From time to time a chicken dies, and, at the end of forty-eight hours, they are all dead. We may take also twenty chickens, previously vaccinated several times, and inoculate them at the same time as the others, with the same virus, in equal quantities. The next day and the next they are all alive and in good health; they eat and cackle as usual; the cocks crow; the inoculated muscles present nothing abnormal. There is not even a sign to show where the skin was punctured. This healthy condition remains permanent.

We may now inquire whether the impossibility of cultivating the parasite is not limited to the muscles which have been inoculated. This may be answered by introducing the deadly virus in the blood vessels and in the digestive organs. I have taken ten chickens, never before inoculated, and ten others inoculated several times with the mild virus. I have then injected the worst form of virus in the jugular vein of all these chickens. The first ten have died rapidly; many of them within twenty-four hours. The ten vaccinated chickens, on the contrary, have only been slightly ill from the incision of the skin and of the jugular vein, and were soon in good health. This shows that the blood of these ten chickens was itself *vaccinated*, which means that previous cultivation had deprived it of the materials fit for further development of the germ.

As to the introduction of the parasite in the digestive organs, I have imitated the epidemics which depopulate poultry yards, by introducing the parasite in the food of the chickens. On the 11th of March I brought together twelve chickens, bought at the market that very morning, and twelve others, previously vaccinated several times. Every day I gave to these twenty-four chickens a meal of the diseased muscles of chickens who had died from chicken cholera. Through the combs of the twelve chickens which had not been vaccinated I passed a platinum wire, so as to distinguish them from the other twelve. On the next day the unvaccinated chickens began to sicken and die. On the 26th of March the experiment terminated. Seven of the chickens that had not been vaccinated have died, and a *post mortem* examination reveals the fact that the disease was introduced in the system, either through the first portion of the alimentary canal, or, more frequently, through the bowels, which were highly inflamed, and sometimes ulcerated, in a manner which recalls the lessons of typhoid fever.* The five other unvaccinated chickens are more or less ill, one seriously so. As to the twelve vaccinated chickens, not oneh as died, and to-day† they are all alive and in good health. We may now sum up the results as follows:

It is the life of a parasite, in the interior of the body, which causes the disease known as chicken cholera, and which causes death by this disease. When the cultivation of this parasite cannot take place in the body of a chicken, the disease does not show itself. The chicken is then in the constitutional condition of animals which chicken cholera cannot attack. Animals, in this condition, may be said to be born vaccinated for this disease, because the fœtal evolution has not placed in their bodies the proper food of the parasite, or because substances, which could serve as such food, have disappeared while they were yet young. We must not wonder that there are constitutions more or less apt to receive inoculations of certain kinds of virus, for, as was announced in my first note, the broth of beer-yeast is entirely incapable of supporting the life of the parasite of chicken cholera, while it is well adapted to the cultivation of a multitude of microscopical germs, notably of the bacteridia of carbuncular disease.

The explanation to which we are led by the facts already mentioned, of the different degrees of constitutional resistance of some animals, as well as of the immunity which chickens acquire by preventing inoculations, must seem a natural one, if we take into consideration that every cultivation modifies the medium in which it takes place. In the case of ordinary plants, the soil is modified; in the case of parasites the animals and plants on which they live are also modified. The same thing happens with the liquids in which they live, in the case of ferments and other microscopical germs. The modifications which take place have this character in common, that new cultivations of the same species in these media soon become difficult or impossible. If chicken-broth is used for cultivating the germ of *chicken cholera*, and if, after three or four days, the liquid is filtered, to separate all the germs, and furthermore, if after this fresh quantities of the germs are placed in the filtered liquid, it will be found incapable of producing the feeblest development. Perfectly limpid at first, the liquid remains indefinitely limpid.

We are led to believe that the cultivation of the attenuated virus in a chicken places its body in the same state as that of the liquid which can no longer sustain the life of the germ of disease. We may extend the comparison still further, for, if we filter the broth on the second day of the cultivation instead of on the fourth, the filtered liquid will still permit the cultivation of the germ, but less readily than at first. This may enable us to understand that the cultivation of the attenuated germ in the body of a chicken may not have removed all the food for the germ. The remainder may allow a fresh cultivation of a feebler kind. This is the same as a first *vaccination*. Subsequent inoculations will remove progressively all the materials for the cultivation of the parasite. Through the action of the circulation a time will come when any new cultivation on the animal will remain unproductive. Then the disease cannot recidivate, and the subject becomes perfectly vaccinated.

It may seem astonishing that the first cultivation could have stopped before all the food of the germ has been destroyed; but we must not forget that the germ is aerobian,‡ and that, in the body of an animal, it does not find the same conditions as in an artificial medium of cultivation, in which there are no obstacles to its propagation. In the body, on the contrary, it finds opposition from the cells of the organs, which are also aerobian, and are continually absorbing oxygen.

We might also account for the fact of non-recidivation by admitting that the life of the germ, instead of destroying certain substances in the body of an animal, on the contrary adds other substances which act as an obstacle to its further development. The history of the life of these inferior beings, of all beings in fact, authorizes this supposition. The excretions due to vital functions often prevent vital functions of the same nature. In some fermentations antiseptic products are formed while fermentation is going on, and even by the action of ferments, and these products put an end to further action, even if there are still substances left capable of undergoing fermentation. In the cultivation of our germ there might, in the same way, be substances formed whose presence might explain non-recidivation and vaccination.

Our artificial cultivation of the parasite will enable us to examine this hypothesis. If we prepare an artificial cultivation of the germ of chicken cholera, we may evaporate the liquid *in vacuo* while cold, then bring it back to its original volume by the addition of chicken broth. If the extract contains a poison which destroys the germ, and if the presence of this poison is the cause of its non-development, the cultivation of the germ cannot take place in this liquid. On the contrary, the development does take place without difficulty. We cannot then believe that,

* Translated from the *Comptes Rendus de l'Academie de Sciences*, of April 26th, 1880, page 932. by P. Casamajor, for the *Chemical News*.

† From all I have seen and read of vaccine in man, and from my experiments on chicken cholera, I infer that *vaccine* rarely acts as a complete preventive. There are cases cited of vaccinated persons who have had the variola, and there are even cases of persons who have had it, afterward, as much as three times.

‡ There are degrees of attenuation as well as of virulence. I will give explanations in a future communication.

* The blood is full of parasites, and the interior organs are frequently covered with pus and false membranes, particularly next to the intestinal pockets, through which the germ seems to have penetrated.

† April 28th.

‡ Pasteur divides germs and other microscopic organisms into *aerobions* (requiring air to live) and *anaerobias* (which do not require air).—*Translator.*

during the life of the parasite, there are substances produced which prevent its further development. This is a corroboration of the opinion which we have expressed on the cause of non-recidivation in certain virulent diseases.

A CASE OF RATTLESNAKE BITE.

By DR. M. L. DICK.

I WAS called on the 29th of June, 1880, to see a boy, six years old, who had been bitten by a rattlesnake. He was bitten about 3 P.M., but the family did not know it for two hours. He had been out in the harvest field, and started from there to return to the house as soon as he was bitten. He was found by the family lying in the orchard, between the field and the house, vomiting and very greatly prostrated. He had thrown up some wheat, and the family supposed he had overloaded the stomach by eating the grain, and they did not know differently till he revived consciousness enough to tell them what had happened. This was about 5 o'clock.

I arrived about 6 o'clock. Found the boy had vomited a number of times, and was suffering greatly from the bite, which was in one limb. The limb was swelling very rapidly, was very dark and green in places. I prepared a mixture of one ounce each third preparation of lobelia, and tinctures lobelia, scutellaria, and valerian. Nearly a teaspoonful of this was given in warm water every five minutes. Prepared a very strong infusion of black cohosh, and, as soon as this was ready, used it to give the above mixture in. We wrapped the limb in a poultice of equal parts lobelia seeds and capsicum in elm powder, wet with third preparation of lobelia, and kept wet with this. Bottles of hot water were placed along the sides. So soon as I had secured free vomiting several times, obtained a free perspiration, and got him fully under the influence of the medicine, I lengthened the time of the dose to half an hour apart.

A very free perspiration was maintained steadily by these means, the medicine being gradually diminished till the doses were one hour apart. In less than an hour from the time the poultice was applied the pain began to abate, and was much relieved before I left for the night.

On the morning of the 30th I found my patient feeling much better. The swelling extended up into the iliac region, the limb was twice the natural size, and the thigh was dark; but he suffered no pain unless the limb was molested, but complained that it felt as sore as a boil when touched. Had him sponged off, removed the bottles of warm water, continued the rest of the treatment.

July 1. Patient much improved. Swelling diminishing, limb not so sore. Prescribed equal parts of fluid extracts scutellaria and cimicifuga and tincture lobelia; two-thirds of a teaspoonful every two hours. Poultice continued as before; with directions that a strong decoction of verbascum should be applied to the limb, and cloths kept saturated with this, when the dark color had mostly disappeared. My direction in this was misunderstood, and they applied the verbascum soon after I left, which I would not have done. But the result was admirable. They said the verbascum gave most surprising relief to the bad feelings, and, when I came to visit my patient again, he met me at the gate smiling and happy.—*Cincinnati Medical Gazette.*

TOBACCO SMOKING BY CHILDREN.

IF we are willing to accept the opinions which sanitarians in other nations have formed, we have a very decided one ready to our hand in Switzerland. That intelligent republic enacted a law, last year, prohibiting the sale of tobacco to minors under fifteen years of age, and making it an offense against the law for such to smoke. Hence a boy of twelve or fourteen who parades the streets of Geneva or Bern with a cigar in his mouth is liable to be arrested and committed to the police station; and as they have a disagreeable habit in that republic of enforcing the laws they enact, such would be pretty certain to be the juvenile smoker's fate.

We recommend to our fellow-countrymen their manner of dealing with the habit, which, whether harmless or not to most adults, is unquestionably of great injury to young boys. —*Med. and Surg. Reporter.*

TREATMENT OF THE INSANE AT GHEEL.

AT a recent meeting of the New York Neurological Society, the paper of the evening was read by Dr. W. J. Morton, the title being,

THE TOWN OF GHEEL, BELGIUM, AND ITS INSANE.

The town of Gheel, according to tradition, became a resort for the insane so early as the seventh century. The patients first came in order to worship at the shrine of St. Dymphna, which had acquired high reputation for its cures. As the fame of the town grew, the insane flocked to it in greater numbers, and the inhabitants gradually adopted the custom of taking into their houses and homes the afflicted persons who came to pray for cure at the sacred shrine. Definite knowledge of Gheel, as a home for the insane, dates from the twelfth century. Since that time its reputation has never waned, and in the past century has steadily increased.

Gheel is a commune in Belgium, numbering about 12,000 inhabitants, who are a mixture of Germans and Gauls. It has no special industry, but the population is principally occupied in agriculture, domestic lace-making, and caring for the insane. They are frugal and industrious, and the general spirit of the town is peaceful and calm, without being exactly behind the age. Most of the population is centered in a town about which hamlets are scattered the distance of about a mile. Among the 12,000 inhabitants there are about 2,000 domiciles, of which nearly 1,000 receive insane patients. All classes of the insane are received at Gheel, except such as required continual restraint, and those who are suicidal, homicidal, or incendiary. The insane population numbers now about 1,600, and is steadily increasing. At the beginning of the century it was 400; in 1868 it was 1,035; in 1876, 1,3?3.

Of this insane population seven-eighths are Belgians, and the rest Hollanders, Germans, French, and English. About 200 are paying patients; the rest are paupers.

The Gheel insane had no regular medical service until the year 1851, when the Gheel system was thoroughly reorganized, and placed under government control.

THE ADMINISTRATION

of all the affairs of the insane now rests in the hands of a "superior commission," composed of: 1, the governor of the province, or his delegates; 2, of the attorney general; 3, of the judge of the canton; 4, of a physician appointed by the government; 5, of the burgomaster of the commune; and 6, of five members nominated annually by the minister of justice. This commission has a salaried secretary, who has very important duties. He makes the reports, conducts the correspondence, has charge of moneys and the books, and is steward of the central infirmary. Any outside towns or asylums having twenty-five or more patients at Gheel may be represented by a delegate. The medical inspector also has a consulting voice. The real working part of the commission is made up of the five appointed members mentioned last. These meet once a week, receive reports, disburse money, distribute the patients, and see that the laws and regulations regarding the care of the insane are carried out.

NOURRICIERS AND HOSTS.

Those families which are willing to receive patients must be duly registered and must have shown evidences of good moral character and ability to provide proper accommodations and food for their insane charges. The families that receive paying patients are called hosts; those that receive paupers are called "nourriciers," or nurses. No family takes more than two patients. Great care is taken to see that these patients are put in surroundings as much like those they were previously accustomed to as possible. A great many precautions are taken to see that the patient is not overworked, and is well cared for in every way. Thus there are four "section guards," who patrol the special district assigned them, and make daily reports to the medical inspector.

THE MEDICAL SERVICE

is under the charge of a medical inspector, Dr. Peeters, aided by three physicians, who have charge of the three separate sections into which the town is divided. Each section physician visits the curable patients at least once a week, and the incurables once a month, their visits being registered in a book. He makes a monthly report to the medical inspector, who in turn reports to the superior commission. The medical inspector makes visits whenever asked, and must, in any event, visit every patient at least three times a year.

THE INFIRMARY

resembles in its main features the ordinary closed asylum. Its purpose is to afford the usual hospital treatment to patients attacked with incidental diseases; to care for the very infirm, and to make a brief charge of cases that suddenly develop a condition of excitement which requires for short periods continuous and special watchfulness and restraint. The patient's stay in the building is expected to be temporary. The business management is under the direction of a steward, the secretary of the commission. The medical duties are entirely distinct from the executive, and are performed by the medical inspector. There were, at the time of Dr. Morton's visit, thirty-seven patients in the building out of an insane population of 1,603. No mechanical restraint was employed.

THE INSANE IN THEIR HOMES.

The liberty which patients apparently have in their homes is really hedged in by carefully considered restrictions, and by systematic care and watchful restrictions. Not only is each patient cared for by his own particular village guardian, but the whole community co-operatively act as voluntary guardians. In a place where nothing is concealed, abuses are not likely to thrive. Public opinion and open dealing are the patient's safeguards. And to this traditional relation between villager and patient must be added the surveillance of regularly appointed officers. The speaker believed that the assertions of Dr. A. M. Shew, in his pamphlet on Gheel, that there was an absence of medical care and an almost unlimited opportunity for the abuse of patients, were entirely incorrect. Abuse was in reality impossible, and the medical care was very skillfully directed. The insane are classified into the "dirty," the "half-dirty," and the "clean." For the first class is paid about nineteen cents a day; for the second, eighteen cents; and for the third, sixteen cents.

About four-fifths of this money goes to the villager; the rest is for medicines and medical attendance. These rates are lower than at any other establishment in Belgium.

The speaker described an inspection which he made of a large number of houses, with especial view to seeing the quarters provided for the patients. These he in every case found to be clean, well ventilated, and supplied with a good bed. The statement of Dr. Shew, that the patients were in many cases stowed away in garrets, lofts, and out-of-the way nooks and corners, was not corroborated by the speaker's observations. A little book is kept by the nurse or host, in which is a record of the patient's history and of the visits paid by the doctor.

Dr. Morton related several cases taken from the records of Dr. Peeters, showing the good effects of the Gheel system upon insane patients brought to the colony.

The number of escapes range from seven to twelve annually. The villager in charge is responsible for his patients, and has to pay for the expense of capture. Patients who escape are quickly captured and returned.

Acts of violence are comparatively rare. Only three instances are known. One of these was a homicide committed in 1840. The other two were acts of personal violence, not resulting seriously. Three suicides have occurred since 1875. Offences against morality are almost unknown.

THE HAMLETS.

In the suburbs of the central town, in every direction, there are groups of farmers' houses. Here a good many of the insane are also domiciled. These houses are not as well kept as those in town, but they make comfortable and healthy houses. The peasants themselves are fine specimens of physical health. Dr. Morton did not agree with Dr. Shew that the houses were damp, and the peasants overworked and under-fed. Everything showed care and kindness on the part of the peasant attendants. To look after their charges seemed to be a settled part of their daily lives.

It is difficult to get a fair estimate of the per cent. of cures at Gheel. for the proportion of incurables is very large. Thus, of 313 patients admitted in 1879, seventy-three were received from other asylums, and all but two were absolute incurables. Reckoning, however, upon the admissions from 1853 to 1870, the per cent. of cures was 24. On the other hand, the proportion, based upon the probably acute cases admitted, was from 79 to 89 per cent.

THE "GHEEL IDEA."

The main characteristics of the Gheel system are its comparative freedom, occupation, and the family life. Gheel is probably an ideal which can never be repeated by any other nation, for the simple reason that there is but one village of Gheel removed from the whole world's traffic and turmoil, where the inhabitants, by reason of centuries of inheritance, have learned a patience sublime in its simplicity, a tact in management born of affectionate regard for their charges, and an absence of timidity impossible to realize until witnessed.

But though the "Gheel idea," the family system, may not be repeatable, the essence of the idea, *i. e.*, a large and reasonable liberty, healthful and sufficient employment, and accustomed and congenial surroundings, is repeatable, though not certainly in any of our great asylum buildings. Gheel teaches us the possibilities that lie in the treatment of the insane, and how woefully wide our advanced civilization is from the mark it might attain in this direction.

SELECTION AND PREPARATION OF FOOD.*

By MISS RUTH SMITH.

Mr. President, and Ladies and Gentlemen:

The selection and preparation of food is the subject before you for discussion this evening, and if you ask, as you well may, why I am the one to open the discussion, I reply that it is in obedience to the expressed wish of your late worthy President, Mr. Cheever.

The human body is composed of the following fourteen elements: Oxygen, hydrogen, carbon, nitrogen, phosphorus, calcium, fluorine, sulphur, chlorine, sodium, iron, potassium, magnesium, and silicon. To supply the constant waste in these elements, which must be done daily, or ill results are sure to follow, a loving Father furnishes us, not only with an almost endless variety of food, with air, and with water, but also with brains to devise and hands to execute ways of preparing it, and our part is to accept these good gifts with thankful hearts and learn to use and not abuse them.

Food may be divided into three classes. That class which supplies the lungs with fuel, and thus furnishes heat to the system and supplies fat, may be called carbonates, carbon being the principal element; that class which supplies the waste of muscles may be called nitrates, nitrogen being the principal element; and that which supplies the bones, the brains, and the nerves, and gives vital power both bodily and mental, may be called phosphates, because phosphorus is the principal element. Of these three classes, four times as much carbonaceous food is required as there is of nitrogenous, and of the phosphates not more than two per cent. of the carbonates, and animal and vegetable foods are equally adapted to supply these necessary elements.

In animal food the carbonates are furnished in fat, and the nitrates in albumen, fibrine, and caseine. In vegetable food the carbonates are furnished in sugar, starch, and a little fat, and the nitrates in gluten, albumen, and caseine. The phosphates, in both animal and vegetable food, are found inseparably connected with the nitrates, none being found in any of the carbonates.

Wheat contains the fourteen elements which constitute the human system; and the proportion of muscle-making, heat-producing, and brain and nerve producing elements are in about the average proportions required in moderate weather, with moderate exercise of bodily and mental faculties, these elements being required in different amounts, according to the employments of the individual and to the temperature of the atmosphere. The man who is chopping wood in an atmosphere at zero, and he who uses only his brain in a room at 70°, consume very different elements in very different proportions, and therefore require very different elements of food.

These fourteen elements are contained in the whole grain, or in unbolted flour, and while bread made from this flour, mixed only with pure cold water, is undoubtedly the more wholesome, we need not necessarily confine ourselves to it as an article of food. In making superfine flour the food for muscles and brains is lost, but this loss can be supplied by eating with bread made from it lean meat, fish, cheese, or any other food containing similar elements.

The flour which contains the most gluten or muscle-making food is not only the most nourishing, but the most economical. Gluten absorbs water, which causes the paste to swell, and in this way housekeepers can judge of the strength of the flour; and when we consider that flour with the most gluten is not only twenty-five per cent. more economical than that with the least amount of it, but that it is also sweeter and more digestible in the same proportion, it becomes a matter of great importance to be able to judge of its richness in gluten. But let your bread be raised with yeast not with soda. Mrs. Richards, who is connected with the school of chemistry for women in Boston, says in her lecture upon "Chemistry in the Household," words to this effect: "Saleratus is in itself an active poison. This poison is neutralized by acids, but if the wives and mothers of our land were aware that in all cases where not entirely neutralized, it acts as a destroyer upon the inner coats of the stomach, causing dyspepsia and its train of horrors, they would banish it as much as possible from their kitchens. Cream of tartar and bicarbonate of soda should be purchased of the druggist instead of the grocer; the soda should be sifted before measuring, to remove the lumps, and the proportions of two spoons of acid to one of soda should be very accurate, evening off each spoonful as carefully as possible."

It is not as safe to use sour milk to neutralize the soda, for there are so many degrees of sourness it is almost impossible to determine the exact amount of soda required, and any excess causes disease.

Next to wheat, rye is the best of the cereals. It contains more heat producing, but less of the muscle and brain producing elements than wheat, and the same is true of Indian corn. Rhode Island "Johnny cake" made without soda or eggs, with meat, fish, or eggs as an accompaniment, furnishes a breakfast good enough, not only for a king, but for any member of the Farmers' Club of Franklin; while rye and Indian together make the wholesome and delicious brown bread of our fathers' time; a very different article from the baker's brown bread of the present day.

Buckwheat is inferior to wheat in its nutritive elements; contains more heaters, and not half the muscle and brain feeders. Eaten alone, therefore, it is not much better than superfine flour, and requires beefsteak or fish to give the necessary food.

Barley is rich in phosphates, but it cannot be made into light bread. In the form of cakes and porridge it is a good brain food, and pearl barley is good in sickness when vitality is low.

Oatmeal is rich in food for muscles and brains; and in one pint of oatmeal gruel there is as much of muscle-making material as in five gills of unbolted meal gruel, or in three quarts of fine flour gruel.

Rice contains little nutriment. It helps out a meal with

* Essay read before the Franklin Farmers' Club, Jan. 15, 1881.

beefsteak, etc., and is good in some cases of sickness, when the stomach is weak and little nourishment is needed.

Beans are rich in nutritious elements, but their muscle making element is not gluten, as in the grains, but caseine, as in cheese, a substance not so easily digested as gluten, and therefore adapted to strong, healthy persons, with good powers of digestion. Two pounds of beans will help do more muscular work than three pounds of wheat, and more brain work than three and a half pounds; but they contain less by twenty per cent. of their requisite of heaters, and for that reason they require to be eaten with pork or plenty of butter. Green beans are not as nutritious as dry, because the starch is not formed in them.

Peas contain nearly the same elements and in the same proportion as beans, but are more easily digested. They require plenty of butter as a heat-giver.

Starch, sugar, and fat are the three chief heat-giving principles of food. Potatoes contain a large proportion of starch, and this makes them valuable in connection with other food. We all know how good baked potatoes are of a cold morning.

Parsnips, turnips, carrots, beets, and onions are so nearly made up of water and waste materials that they cannot be depended upon for nournishment, but are most valuable aids in digesting the more concentrated foods, and this is true of all other green vegetables, also of fruits and berries, which are all given at the seasons when most needed, and which are most useful when most relished.

The flesh of animals, lean and fat together, contains, as does wheat, every one of the fourteen elements of which the human system is composed, but not in the same proportions; and the five articles of animal food, beef, mutton, veal, lamb, and pork, on which we principally depend, differ in their proportions of nutritive qualities, and are, therefore, adapted to different temperatures and different circumstances. If farmers knew how good really good mutton is, and what a variety of wholesome and appetizing dishes can be prepared from it, it would be oftener seen upon their tables. Hot plates are as necessary to it as they are to beefsteak or fish.

Fish contains about the same elements as lean beef and mutton, the only remarkable difference being in the amount of phosphates, which are much larger in the fish. Food which contains the right proportion of heaters and muscle makers is not only best, but most economical, for all the food beyond the amount necessary to supply the element that is deficient, is not only wasted, but burdens the system with efforts to dispose of it. For instance, suppose we have a meal of roast beef or mutton, rare, with potatoes and dish gravy, bread of unbolted wheat or of rye and Indian, fruits and cheese, or if the meat is lean we have green vegetables, butter or pork to supply the heating principles. With such a meal the appetite would be entirely satisfied with just the amount of food necessary to supply either the heating or the muscle-making principles; but suppose instead we tried to satisfy the appetite with a meal of fried fat pork and potatoes, fine white bread and butter, griddle cakes and sirup, articles almost destitute of food for muscle and brain—when the stomach was filled there would still be a demand for the nitrates or phosphates, and we should still crave some article to supply the deficiency, and all the carbonates above those which the system required would be wasted. On the contrary, if we ate only lean meat or fish, and green vegetables and fruits, the system would call for carbonates, and if not supplied, the lungs would not have sufficient fuel to run the machine. As far as we have articles of food deficient in carbonates, we can use without loss butter and sugar, but all meats, fat and lean together, all grains and milk, contain all the carbonates that are needed or that can be used in moderate weather, so that in most cases the pies, cakes, and custards we eat are worse than useless, as by adding too much fuel they increase the tendency to inflammation, embarrass the stomach, and induce dyspepsia, etc. With beefsteak or any lean meats, or fish, potatoes, dried beans, peas or any green vegetables, some rich oily substance is called for to supply the needed carbon, and in common use we have our choice between lard, sweet oil, butter, or fat pork, and it would seem that for each person that is most wholesome which is best relished. From the time of Solomon, whose good wife believed in early and nourishing breakfasts, down to the present day, we have written evidence of the paramount importance of the subject before us.

When the world was 2,280 years younger than it is now, Socrates is represented as saying to Ischomachus, "Did you bring your wife to this perfection, as a housekeeper, or did her father and mother teach her?"

"As she was but fifteen when I married her," said Ischomachus, "she had seen very little, heard very little, and spoken very little of the world, and, therefore, I questioned, then instructed her. Methinks," continued he, "that God hath caused nature to show plainly that a woman is born to take heed of all such things as should be done at home. He has ordained that the woman should keep those things that the man getteth and brings home to her. Likewise the law shows and the God commanded that it is best for both the man and the woman to do their part; and so the wife is to beware that the year's income be not spent in a few months. She is to see that the wool is brought in, is made into cloth, and that the corn be cared for and examined, that none of the musty and dirty be eaten as food. And now good Socrates," said Ischomachus in conclusion, "be sure that my wife lives even as I have taught her and have told to you."

Rather more than a hundred years ago the accomplished Lady Mary Wortley Montagu, who moved in the fashionable as well as the literary circles of the day, wrote these words:

"The most minute details of household economy become elegant and refined when they are ennobled by sentiment. To furnish a room is no longer a common-place affair; shared with upholsterers and cabinet-makers, it is decorating the place where I am to meet my friends. To order a dinner is not merely arranging a meal with my cook, it is preparing refreshment for those whom I love. These necessary occupations, viewed in this light by a person capable of strong attachments, are so many pleasures, and afford her far more delight than the games and shows which constitute the amusements of the world."

In sharp contrast to the above is this quotation: "A man's heart and his stomach are said to be interchangeable terms." I would not so far malign the sterner sex as to indorse this sentiment, yet I certainly know of more than one instance where a woman's sole tie to an unloving, selfish, cold husband, has been her power of deftly administering to his chronic dyspepsia. I have seen this despised faculty avert divorce and preserve family unity where all else failed and love had never been. The moral of which is—young ladies, learn to cook well."

This quotation is from "Amanda," in the October number of *Harper's Magazine* for 1880.

Can there be anything sadder than this? Yes, a home where love has been, but where she, whose duty it is, and whose great happiness it should be, to care for the health and comfort of the household, is willing to trust both to one who is ignorant of all laws of health and life; who never having seen soda in her own land, after learning that it makes things light, uses it as the nucleus of all her compounds, around which other things are to be stirred. Dyspepsia and discomfort follow, and if love survives it is more owing to the fact that it is indestructible than to the fostering care of the housewife.

I never blamed an acquaintance of mine for first getting cross and then as glorious as "Tam O'Shanter," when his wife ordered the twenty-five pounds of corned beef, two hams, and half a dozen tongues, which he had sent home, to be put in the set boiler and boiled, at a gallop, probably, for two hours. Nor was it surprising that he should declare with considerable emphasis that "A woman has no more right to become a wife before she has learned to keep house in all its departments, than a man has to practice law or medicine without studying his profession."

To the "Philosophy of Eating," by Dr. Albert J. Bellows, I am indebted for my information upon the chemistry of the human system and of food. This work, and "How Not to be Sick," are in our public library—they ought to be in every family.

In conclusion, dear friends, I most earnestly hope that the result of the discussion this evening will so bring the importance of this subject to our minds that fathers and mothers, men and women, we will work together in our homes, neighborhoods, and schools, till boys and girls are made to feel the dignity and worth of this part of their education.

VAPORS FOR INHALATION.

THE following are selected by the *Monthly Magazine of Pharmacy* from the formulæ used at the Hospital for Diseases of the Throat in London:

Vapor Caryophylli.

Oil of cloves	30 minims.
Light carbonate of magnesia	15 grains.
Water	3 ounces.

Vapor Cassiæ.

Oil of cassia	20 minims.
Light carbonate of magnesia	10 grains.
Water	3 ounces.

Vapor Cinnamomi.

Oil of cinnamon	20 minims.
Light carbonate of magnesia	10 grains.
Water	3 ounces.

Vapor Creosoti.

Beechwood creosote	3 drachms.
Glycerine	3 "
Water	3 ounces.

Vapor Cubebæ.

Oil of cubebs	2 drachms.
Light carbonate of magnesia	60 grains.
Water	3 ounces.

Useful in laryngorrhœa.

Vapor Cubebæ c. Limone.

Oil of cubebs	1½ drachms
" lemon	½ drachm.
Light carbonate of magnesia	60 grains.
Water	3 ounces.

The oil of lemon is added to mask the disagreeable odor of the cubebs.

A teaspoonful to be added to a pint of water at the desired temperature, 150° F., and an additional teaspoonful to be added every five minutes during the time that the inhalation is used. Not more than three teaspoonfuls to be used on any single occasion.

QUININE FOR HYPODERMIC USE.

PROF. J. T. WHITTAKER, of Cincinnati, discussing the relative values of the various preparations of quinine for hypodermic use, mentions the insolubility of quinia (alkaloid); the irritating character of solutions of the sulphate secured by means of alcohol or acids, and quotes Eulenberg's statement that the bi-sulphate of quinine, dissolved in glycerin, will keep for four months. With the aid of heat, three parts of glycerin will take up one part of the salt, thus permitting 10 to 15 grains to be administered with each syringeful.

Muriate of quinia, which is relatively richer in quinine than the sulphate (83·6, 74·3), is more soluble, more quickly absorbed, and less liable to decomposition, but it is also more expensive ($4.00 to $2.85 per oz.).

The ferro-citrate, bitartrate, lactate, and other salts have been used, but contain relatively less quinine.

The hydrobromate or the neutral bromide is the best for this purpose, according to the observations of numerous experimenters. Although less soluble than the bisulphate, it is richer in alkaloid, and dissolves, with heat, in 15 parts of water or in 4 parts of glycerin.

Prof. Whittaker recommends the following method: Into a test-tube put twenty grains of bromide of quinine and two drachms of water, and cork the tube. In order to use it, heat the tube (without smoking it) over a flame, and in two or three minutes solution of the crystals will have taken place. Pour a quantity into a teaspoon, that has previously been warmed, and from thence it may be drawn into the syringe (also warmed), and immediately injected *under* the skin. The usual half-drachm syringe will contain the equivalent of five grains of the salt.—*Cin. Lancet and Clinic.*

PREDISPOSING CAUSES OF PHTHISIS.

1. THE polar regions are not favorable to the development of phthisis. It is scarcely met with and increases slowly.

2. The temperate regions are the chief locality of the disease—especially in crowded towns.

3. Tropical regions, all things else considered, indicate a more rapid growth of the disease and cause greater ravages.

The influence of race is least of the causes. Heat and cold have no special influence on the kind of phthisis. High altitude has a comparatively beneficial influence. Insufficient and putrid air, bad alimentation, alcohol in excess, want of muscular exercise, all favor the increase of pulmonary tubercle. It is a malady of civilization which ought, in a great measure, to be prevented, and which concerns everybody, from the pupil in the school to the poor living underground in hovels.—*Gazette Medicale.*

DIPHTHERIA AND OZONE.

OZONE is reputed to be capable of curing all cases of diphtheria. Dr. Jochheim makes the gas by mixing slowly thirty grammes of permanganate of potassium with the same quantity of concentrated sulphuric acid, perfectly pure, in a space of twenty-five centiliters—a little over eight ounces. The same apparatus serves as an inhaler. The gas is directed against the local diphtheria deposits on the tonsils and fauces from three to five minutes, repeating the operation every one or two hours, according to the severity of the case. With very small infants the mouth is kept open by a flattened cork. If cough is produced then the gas is introduced by the nostrils. He also uses gargles of permanganate of potash, and also gives internally a powder of three centigrammes (four tenths of a grain) and twelve centigrammes (nearly two grains) of muriate of quinia, mixed with honey for children, in order that the ozone may be mixed with the acids of the stomach.

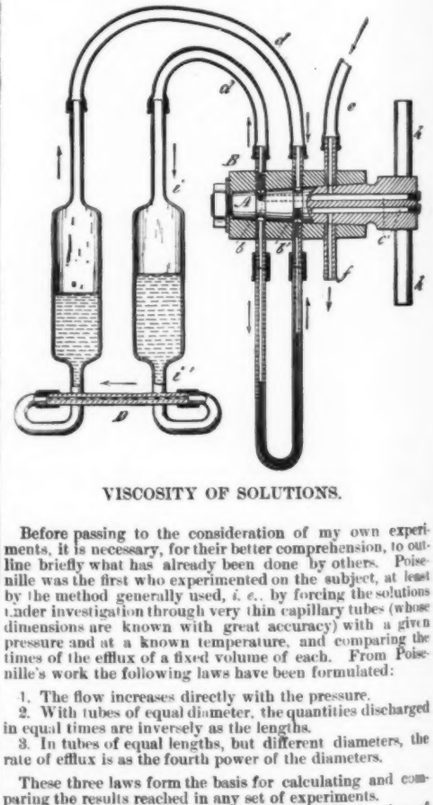
The topical and internal treatment by ozone would be inefficacious unless assisted by a diet of easy digestion to strengthen the system, and composed of rich soups, wines of Bordeaux, ales, champagnes, cognac, and rum. Naturally all depressing measures like emetics, purgatives, and bleeding must be avoided.—*Revista Madrid.*

ON THE VISCOSITY OF SOLUTIONS.

By B. T. TRUEBLOOD, Ph.D.

MOLECULAR physics is necessarily theoretical and speculative. It is probably more fascinating on that account. The molecule lies so near the limits of our scrutinizing powers that it is ever provoking our adventure; and any research that sheds light on it is in demand. The present investigation may cast but a single beam, yet it is concerned, theoretically and directly, with it.

This viscosity of solutions is affected to a greater or less extent by the number and particularly the volume of the molecules held by the solvent. The introduction of a soluble salt into water does not always *increase*, however, its viscosity, as one might at first think. Just what effect it will have can be learned by trial only, except, perhaps, in a few cases where bodies quite similar in their physical properties as well as in their chemical composition are concerned. In general, similarly constituted bodies only bear comparison, such as the members of a series of organic acids, alcohols, ethers, or hydrocarbons, and also sugars and allied bodies. To harmonize all the results reached by Poisenille, Graham, Rellstab, Sprung, and others in any well defined general law is a task as hopeless as the end is desirable.



VISCOSITY OF SOLUTIONS.

Before passing to the consideration of my own experiments, it is necessary, for their better comprehension, to outline briefly what has already been done by others. Poisenille was the first who experimented on the subject, at least by the method generally used, *i. e.*, by forcing the solutions under investigation through very thin capillary tubes (whose dimensions are known with great accuracy) with a given pressure and at a known temperature, and comparing the times of the efflux of a fixed volume of each. From Poisenille's work the following laws have been formulated:

1. The flow increases directly with the pressure.

2. With tubes of equal diameter, the quantities discharged in equal times are inversely as the lengths.

3. In tubes of equal lengths, but different diameters, the rate of efflux is as the fourth power of the diameters.

These three laws form the basis for calculating and comparing the results reached in any set of experiments.

Poisenille found that the transpiration time (the time of efflux of a fixed volume) of a solution was greater than that of distilled water in the majority of cases. This was true with all the alkalies. Mercuric chloride, iodide of sodium, and a few other substances had no effect, while sulphydric acid, prussic acid, and some others actually decreased the time of outflow.

No connection was discovered between the rate of efflux of a liquid and its density, capillarity, or fluidity. He also shows it to be highly probable that various substances in solution when introduced into the blood of a living animal, provided they do not coagulate the serum, produce effects on the capillary circulation corresponding to those produced in capillary tubes. This was true with iodide of potassium when injected into the veins of the horse. This will, doubtless, explain the well-known fact, that when alcohol is introduced into the human system the temperature of the body is lowered; as the transpiration time of alcohol is a great deal *more* than that of water, the capillary circulation would consequently be retarded and the temperature lowered.

Graham's inquiries were directed chiefly to the relation between the rate of transpiration and the chemical composition of the liquids. He found that a small quantity of colloid greatly retarded the flow; that the transpirability of different salts generally follows their diffusibility in water;

that the three-atom hydrate of methylic alcohol behaves like the same hydrate of ethylic alcohol, though not accompanied by condensation as the latter is; that the order of succession of individual substances in any homologous series is indicated by their degree of transpirability as clearly as by their comparative volatility—the largest molecules having the slowest rates.*

Rellstab's† researches were made on the various organic homologues. He finds, as do all experimenters, that the viscosity of all bodies decreases as the temperature increases; but the quantity of gas set free in the substance has no observable influence on the viscosity; that for an increase of CH_2 in the chemical constitution of all bodies there is an increase in the viscosity, which increase is greater in the alcohol radical than in the acid radical; all increase or decrease of viscosity corresponds with the increase or decrease of the boiling points, without being a simple function of the same.

Guerout‡ has experimented more recently on some of the same bodies with corresponding results, also done other valuable work on the subject.

Sprung's§ experiments were on the various salt solutions. He found that the viscosity of water was decreased at lower and increased at higher temperatures by the introduction of a soluble salt, an unexpected result.

APPARATUS FOR DETERMINING THE VISCOSITY OF LIQUIDS.

The essentials in the line of apparatus are:

1. A uniform cylindrical capillary tube, the length and diameter of which are known with exactness.

2. A bulb or bulbs to connect with the tube, the capacity of which is known.

3. A constant known pressure which can be applied to drive the liquid through the tube.

4. A suitable vessel to contain water with which to control the temperature of the liquid and apparatus.

5. A good thermometer, sensitive enough to be read to the tenth of a degree C. with the eye.

6. An accurate timer.

The capillary tube is the most difficult part of the apparatus to secure; its diameter should not exceed 0·3 mm., and it must be perfectly uniform, or at least must not vary as much as one-half per cent. from uniformity. Its cross section should be a perfect circle also. Its length about 15 cm. In the construction of my apparatus I sought to eliminate every source of error possible. To this end I had a reversible faucet made through which the pressure was admitted to the tube. To use this, my capillary apparatus must differ essentially from that of other experimenters This will be readily understood by reference to Fig. 1. A is the movable, B the fixed part of the faucet; C C the bulbs to contain the liquid experimented on, and D the capillary tube. *g* is a mercury manometer, and *d* rubber tubing to connect the parts. The holes, *e*, were drilled in, the one as far as and opening into the annular groove, *b*, the other opening into the groove, b^1; these grooves make connections with two outlets each, one of which goes to the manometer, the other to one of the bulbs, in each case. The pressure is admitted at *e*, and its course through the apparatus is shown by the darts. When A is turned through a half revolution by means of *h h*, the direction of the pressure is reversed, as will be seen by inspecting the figure.

This arrangement of the apparatus will be found not only to result in a great saving of time, but in more accurate results. When the solution to be operated upon is once in the bulb, C, as many observations can be made on it as one wishes without refilling, by simply turning the faucet and thereby reversing the direction of the pressure, and noting the time required for the liquid to pass from *i* to i^1 or the reverse. This part—the bulbs and tube—is immersed in water in a double walled vessel with glass sides, to regulate the temperature. A very slight change of temperature has considerable effect on the time required for the liquid to pass through the tube from one bulb to the other. A great deal of care is necessary in putting the liquid into the bulb to keep out all trash or motes that may be floating in the air, and that would stop the tube; of course the liquid itself must be free from all solid particles.

The various experimenters have, naturally enough, made distilled water a basis for comparing results and for testing the accuracy of the apparatus employed. I give below a table showing the results obtained by Poisenille, Graham, Rellstab, Sprung, and myself on distilled water, at the temperatures in the first column. The time is a function of the viscosity and is given in the table, that required for the transpiration of a fixed volume at zero being taken as 100. From the table it is seen how rapidly the viscosity (or time) decreases with the rise of the temperature; the viscosity at 50° C. being less than one-third of that at 0°.

Temperature.	Pois.	Graham.		Rellst.	Sprung.	Trueb.	Mean.
		I.	II.				
0°	100	100	100	100	100	100	100
25		49·5	50 5	48·7	50·5	50·6	49·9
30	45·2	44·7	45	45	45 1	45	45
35		40·2	41·1	40	40·7	40·7	40 5
40	37	36 8	37	37·2	37·1	37 2	37 1
45		33·9	33·9	34·5	34	34·1	34·1
50	30·8	31·1	31	31·2	31·3	31·4	31·1

The viscosity of a liquid is due to the resistance of motion between adjacent surfaces. We are not concerned now with the mathematical considerations involved in its computation. Our present purpose is with the results of experiments on some organic bodies, and with what bearing these may have, if any, on the molecular formulæ of the same. If, between two smooth straight surfaces, powders of various degrees of fineness be introduced, the friction between the surfaces will increase as the powder increases in coarseness. Some modification of this general statement will be necessary, depending on the nature of the powder and its relation to the surfaces. I see no reason why the same thing is not also true with liquid surfaces. If the molecules of a dissolved body are larger than those of the solvent, they will project beyond the surface formed by a layer of this solvent, of the thickness of a molecule, and consequently retard the motion of this layer on its neighbor. The amount of this retardation will be a function of the size and number of the molecule introduced. There will, also, be modifying influences here, depending on the nature of the bodies concerned, the affinity of the two bodies, and their consequent combination, thus making larger molecules and groups of molecules that move together.

With substances that have a close chemical constitution, however, comparisons are of interest and worth the pains of making them.

During the last winter I undertook a series of investigations on the viscosity of the sugars, dextrine, and gum arabic. Space will not allow of but a very few of the results.

By assuming the time required for the transpiration of a given volume of distilled water, at 30° C., as 100 seconds, that required for the same volume of a 5 per cent. solution of

Cane sugar is	114·6	seconds, or	14·6	seconds longer.
Grape " "	113·7	"	13·7	"
Milk " "	114·4	"	14·4	"
Dextrine, "	142·4	"	42·4	"
Gumarabic, "	312·8	"	212·8	"

There is a curious agreement in these figures; the average of the sugars is 14·2, dextrine is just three times 14·1 (3× 14·1=42·3), and gum arabic is 15×14·2. What is the reason for this coincidence? It would seem as though the molecule of dextrine is three times as large as that of sugar, and that the molecule of gum arabic is fifteen times as large, and also that the sugars differ but little in the volume of their molecules.

With solutions of greater strength dextrine and gum arabic, or at least dextrine, departs a little from being so exact a multiple of sugar.

In order to test the accuracy of these relations I determined the relative diffusibility of the sugars. It is well known that the rate of diffusion of any substance in water depends directly on the volume of its molecules—the less the molecule the greater the diffusion and *vice versa*. The results are given below:

	Formula.	Molec. weight.	Trans. time.	Diffus'n ratio.
Cane sugar.....	$C_{12}H_{22}O_{11}$	342	14·6	9·05
Grape sugar.....	$C_6H_{12}O_6.H_2O$	198	13·7	11·05
Milk sugar.....	$C_{12}H_{22}O_{11}H_2O$	360	14·4	10·9
Dextrine	$C_6H_{10}O_5$	164	42·4	
Gum arabic.... ..	$C_{12}H_{22}O_{11}$	342	222·8	

The tendency of these bodies to undergo chemical decomposition interferes considerably with getting their diffusion ratios: yet the results obtained agree in direction in every case. The transpiration time of cane sugar is the greatest, its diffusibility should by theory be the least, which agrees with the experiment, so also with the other two. Reasoning from the transpirability and diffusibility to the formulæ and molecule, it seems that the formula of grape sugar ought to be doubled, as its *molecular volume* can differ but slightly from that of cane sugar; or if not its molecule is of about half the density of that of cane sugar. By writing the formula, $C_{12}H_{24}O_{12}H_2O$, and allowing some condensation more than takes place in cane sugar, the results are harmonized. Dextrine accordingly would be $3(C_{12}H_{20}O_{10})$, or $C_{36}H_{60}O_{30}$, and gum arabic $15(C_{12}H_{22}O_{11})$, or $C_{180}H_{320}O_{150}$.

HOT ICE.*

PRELIMINARY NOTE ON THE EXISTENCE OF ICE AND OTHER BODIES IN THE SOLID STATE AT TEMPERATURES FAR ABOVE THEIR ORDINARY MELTING-POINTS.

By THOMAS CARNELLEY, D.Sc., Professor of Chemistry in Firth College, Sheffield.

IN the present communication I have the honor to lay before the Royal Society a detailed description of experiments, proving that under certain conditions it is possible for ice and other bodies to exist in the solid state at temperatures far above their ordinary melting points. On a future occasion I hope to submit to the society a full account of the investigation of which these experiments form a part, together with the conclusions to be drawn therefrom. The bodies whose behavior I propose to discuss at present are ice and mercuric chloride.

ICE.

In the case of ice the great difficulty to be overcome is to maintain the pressure in the containing vessel below 4·6 millims., *i. e.*, the tension of aqueous vapor at the freezing point, for it will be easily understood that if the ice be but slightly heated the quantity of vapor given off would soon be sufficient to raise the pressure above that point. After several fruitless attempts the following plan, involving the principle of the cryophorus, was adopted.

A strong glass bottle, such as is used for freezing water by means of Carré's pump, was fitted with a cork and glass tube, and the cork well fastened down by copper wire and paraffin wax. The tube and bottle were then filled with mercury, and the bottle connected with the end of the tube by means of the piece of stout India-rubber pump tubing, a thermometer having been previously attached by a wire to the lip of the tube. The connection was made tight by fine copper wire and wax. The tube was about one inch in diameter, and about four feet long from the bend; after connection with the bottle it was completely filled with mercury, care being taken to expel the air as completely as possible; the whole was then inverted over the mercurial trough, when the mercury fell to 0, the ordinary height of the barometer. The mercury was run out by tilting up the bottle and inclining the tube. By this means a Torricellian vacuum was obtained in the flask and upper part of the tube. The tube was next brought to the vertical, and the bottle placed in a trough. A tin bottle without a bottom was fitted with a cork, so that it might slide somewhat stiffly along the vertical tube.

To begin with, the tin bottle was placed in position and filled with a freezing mixture of salt and ice. Some boiled water was then passed up the tube, sufficient to form a column about two inches deep. The thermometer had been previously arranged so that its bulb might be one or two inches above the surface of the water. The bottle was next surrounded by a good quantity of a freezing mixture of salt and ice, in order that any vapor given off from the water in the tube might be condensed in the bottle as fast as it was formed, and thus the internal pressure might never be more than about 1·0 to 1·5 millims. When the bottle had been sufficiently cooled, which required about fifteen minutes, the tin vessel was slid down the tube and its freezing mixture removed. The water had then solidified to a mass of ice, which on heating with the flame of a Bunsen burner melted either wholly or partially, and the liquid formed began at once to boil. The fusion commenced first at the bottom of the column of ice, whereas the upper part fused with difficulty, and required rather a strong heat. The fusion in this case was probably due to the steam evolved from the lower portions of the ice column being imprisoned and unable to escape, and hence producing pressure sufficient to cause fusion.

When the greater part of the ice had been melted the tube was tightly clasped by the hand, the heat of which was sufficient to produce a somewhat violent ebullition. The liquid in boiling splashed up the side of the tube and on to the bulb of the thermometer, where it froze into a solid mass. By this means the ice was obtained in moderately thin layers The tube at points indicated by the arrows was then strongly heated by the flame of a Bunsen burner, with the following results:

The ice attached to the sides of the tube at first slightly fused, because the steam evolved from the surface of the ice next the glass being imprisoned between the latter and the overlying strata of ice could not escape, and hence produced pressure sufficient to cause fusion; but as soon as a vent hole had been made fusion ceased, and the whole remained in the solid state, and neither the ice on the sides of the tube nor that on the bulb of the thermometer could be melted, however great the heat applied, the ice merely volatilizing without previous melting. The thermometer rose to temperatures varying between 1·0° to 180° in different experiments, when the ice had either wholly volatilized or had become detached from the bulb of the thermometer. The ice attached to the latter did not partially fuse at the commencement of the heating, because, the heat reaching the outer surface of the ice first, evaporation could take place from a free surface and the vapor not become imprisoned, was the case with the ice attached to the sides of the tube.

These experiments were repeated many times and always with the same result, except in one case in which the heat applied had been very strong indeed and the ice attached to the sides of the tube fused completely. On removing the lamp, however, for a few seconds the water froze again, notwithstanding that the portion of the glass in contact with it was so hot that it could not be touched without burning the hand.

The chief conditions necessary for success appear to be—(1) That the condenser is sufficiently large to *maintain* a good vacuum: in the present case the capacity was about three-quarters of a liter. (2) That the ice is not in too great mass, but arranged in thin layers. Further, in the case where the heat is applied to the under surface of the layers of ice, the latter must be sufficiently thin to allow of a vent hole being formed for the escape of the steam coming from below, otherwise fusion occurs. When the heat is applied to the free surface of the ice the layers may be much thicker.

MERCURIC CHLORIDE.

m.p.=288°, re-solidifies at 270° to 275°, b.p.=303°.

About 40 grammes of pure mercuric chloride were placed in a tube, and a thermometer arranged with its bulb embedded in the salt. The drawn out end of the tube was connected by stout India-rubber tubing with one branch of a three-way tube, whilst the other was attached to the manometer. The remaining branch was connected with a Sprengel pump, fitted with an arrangement for regulating the pressure.

When the pressure had been reduced by means of the pump to below 420 millims., the mercuric chloride was strongly heated by the flame of a Bunsen burner, with the following results:

Not the slightest fusion occurred, but the salt rapidly sublimed into the cooler parts of the tube, while the unvolatilized portion of the salt shrank away from the sides of the tube and clung tenaciously in the form of a solid mass to the bulb of the thermometer, which rose considerably above 300° C., the mercury of the thermometer shooting up to the top of the stem. After slight cooling the air was let in, and under the increased pressure thus produced the salt attached to the bulb of the thermometer at once melted and began to boil, cracking the tube at the same time.

The experiment was next varied as follows:

About the same quantity of chloride was placed in the tube as before, and heated by the full flame of a Bunsen burner. The lamp was applied during the whole of this experiment, and the size of the flame kept constant throughout. The mercuric chloride first liquefied and then boiled at 303° under ordinary pressure, and while the salt was still boiling the pressure was gradually reduced to 420 millims., when the boiling point slowly fell to 275°, at which point the mercuric chloride suddenly began to solidify, and at 270° was completely solid, the pressure then being 376 millims. When solidification was complete the pump was stopped working, but the heat still continued to the same extent as before. The salt then rose rapidly to temperatures above that at which a thermometer could be used, but not the least sign of fusion was observed. From the completion of the solidification to the end of the experiment the pressure remained at about 350 millims.

The above experiment, which was repeated three times, shows, therefore, that when the pressure is gradually reduced from the ordinary pressure of the atmosphere to 420 millims., and the boiling point simultaneously from 303° to 274°, the salt solidifies while it is still boiling and in contact with its own hot liquid, notwithstanding that it is being strongly heated at the same time; and that, after solidification is complete at 270°, the temperature then rises far above the ordinary boiling point (303°) of the substance without producing any signs of fusion. Under ordinary circumstances, mercuric chloride melts at 288° and re-solidifies at 270° to 275°, *i. e.*, at a temperature identical with that at which it solidifies under diminished pressure, as above described.

The solid mercuric chloride obtained on solidification under the combined influence of diminished pressure and the application of a strong heat had a peculiar appearance, quite different to that produced when the substance is allowed to solidify in the ordinary way. It appeared to consist of a mass of pearly leaflets closely packed together round the bulb of the thermometer.

Any final explanation of these phenomena is reserved until further experiments have been made.

APPENDIX.

Since writing the foregoing, it has been said in explanation of the phenomena therein described, that the thermo-

* Further information concerning Poisenille's and Graham's researches can be found in "Watts' Dictionary," vol. iii., p. 722, where quite a full account is given.

† See "Ueber Transpiration homologer Flussigkeiten," Bonn, 1868.

‡ See *Comptes Rendus*, tome 78, p. 351; tome 79, p. 1301; tome 81, p. 1032; and particularly tome 83, p. 1291.

§ See "Experimentelle Untersuchungen ueber die Flussigkeitsreibung bei Salzlosungen." Berlin, 1876.

* A paper read before the Royal Society, January 6, 1881.

meter, though embedded in the mass of ice, did not really indicate the true temperature of the letter. With the object, therefore, of proving whether the ice is hot or not, I have, at the suggestion of Professor Roscoe, made the following calorimetrical determination:

The arrangement of the apparatus was so modified that the ice, after being strongly heated, could be suddenly dropped into a calorimeter containing a known quantity of water of known temperature. The resulting temperature, after the ice had been dropped in, was read off by a thermometer graduated so as to indicate a difference of 0·05° C. The weight of the ice was found by re-weighing the calorimeter.

So far I have only had the opportunity of completing the two following determinations, and in the second of these the weight of the ice could not be found, as a small quantity of water was lost out of the calorimeter, owing to a sudden jerk at the moment the ice entered it:

(1.) Weight of water in calorimeter, including the value of the latter=185 grammes.
Weight of ice dropped in=1·3 grammes.
Temperature of calorimeter before=13·4°
" " after = 13·6°

Rise in temperature=0·2°

$M(\theta-\theta) + 80W = W(T-\theta)$
$(185\times0·2)+(8·1\times1·3)=1·3T-13·6)$
$\therefore$ T=122° C. Where T=temperature of ice.

(2.) Weight of water in calorimeter, etc.=185 grammes.
Temperature of calorimeter before=12·7°
" " after = 12·8°

Rise in temperature=0·1°

On weighing the calorimeter after the experiment, the increase in weight was only 0·15 gramme, but as a portion of the water had been jerked out during the operation the true weight of the ice, and therefore its temperature, could not be found. But since the calorimeter had slightly risen in temperature, the ice must have been above 80° C.

From the nature of the experiment, as carried out on the present scale, the weight of the ice which can be dropped into the calorimeter is only small, and therefore the rise in temperature is but slight. But since a fall in temperature of a much larger amount ought to have been obtained had the ice been at 0°, it is considered that the above experiments are conclusive. Great care was taken in order to obtain correct temperatures in the calorimeter. The latter was inclosed in several casings, and the water was allowed to stand in it for several hours before the experiment, so that it might first attain the temperature of the room, while the time which elapsed between the readings of the thermometer before and after the ice was dropped in would not be more than from ten to fifteen seconds.

In the course of the next few weeks I intend to make one or two more determinations, and, if possible, on a larger scale.

ADULTERATION OF FOODS.

ONE of the most interesting recent contributions to this branch is a report on an investigation to determine the prevalence of adulteration in food supplies, undertaken, in accordance with instructions from the National Board of Health, by Dr. Smart.

Tea.—Dr. Smart does not consider the so-called "facing" of teas with Prussian blue and silicates as injurious. Mixing teas is very common in this country, but it is not harmful to health. His general results were as follows:

The teas examined numbered 117, but of these two which were grown in Georgia, and six sent specially from Japan, may be excluded from present consideration. Of the 109 remaining, 90 were obtained from sources which presumably should have furnished a pure article, while 19 were purchased at such stores as might be expected to furnish an adulterated article, if adulteration was at all prevalent. In no case was a leaf observed which was not a true tea leaf. Of the 90 the only cases of debasement were those already mentioned as having probably originated before importation, while 5 of the 19 were so deteriorated that an analyst would have been warranted in reporting them as fraudulently adulterated—one, gunpowder (Y 2) from an excess of lime sulphate facing; one imperial (W 2), from admixture with sand, and three, imperials (Y 1, 2, and 3), from the presence of exhausted leaves. Whether these debasements were effected in China or in this country is an open question; but from the character of the English importations it is probable that exhausted leaves are dried and recolored in this country, for sale among the poorer classes of the community.

Coffee.—In this popular beverage something more positive was reported; but, on the whole, the examination did not yield serious results. The investigator says:

Most of the dealers with whom I have conversed have been strong in their belief that adulterated coffee is not to be found in this country, as the beans are either home-ground or ground by the supplying grocer. The results of H. B. Hill's examination for the State Board of Health of Massachusetts sustains this opinion, as ten samples of ground coffee, obtained in bulk, were found to be pure, while seven package samples consisted of one with no coffee, two with very little, and four with from fifty to seventy per cent. of coffee, the rest being roasted wheat, peas, beans, and chiccory. But the supplying grocer is not to be trusted in all cases, as out of the few purchased samples of loose ground coffee which have been examined during the present investigation, one contained a small percentage of chiccory, while two consisted largely of chiccory and roasted beans. Only one sample of package coffee was received, and it sustained the accuracy of Dr. Hill's results. Chiccory, corn, wheat, and rye were noted on the microscopic field as adulterants; but adulterants of what? for no coffee had been discovered, and half a dozen successive slides carefully examined failed to show the presence of the nominal article.

Three extracts or essences of coffee were examined, one of which consisted of chiccory and the two others of roasted starches. Two of these bore on the label an offer of a reward for proof that any other extract of coffee was as pure as they, which does not say much in a general way for the purity of extract of coffee. Two samples of chiccory were examined, both of which were found pure.

Sugar.—Cane sugar seems widely adulterated by glucose manufactured from starch. On this point the result was as follows:

Among 47 brown sugars, most of which were furnished by dealers who knew that their samples would be examined, there were found 3 which contained glucose, while among 38 samples purchased for analysis no less than 9 were thus adulterated. The glucose varied from a small admixture of thirty per cent. A remark by one of the dealers who furnished a thirty per cent. sugar is worthy of mention in this place: "*Oh!* they all have it, but they don't send any of it to *you*." Another storekeeper from whom a degraded sugar was obtained remarked, as he was putting up the samples, that I was welcome to anything he had, as he did not suppose he was any worse than his neighbors.

The white sugars, powdered, granulated, etc., were free from this adulteration; 24 of them were furnished dealers and 15 were purchased. The sirups, of which 21 were sent in for examination and 12 purchased, were also pure.

Flour.—This important staple furnishes gratifying results. Of 58 samples examined, only 1 had any adulteration, and this was merely corn meal, probably introduced by accident. The same cannot be said of bread.

Bread.—Of 18 samples, 8 contained alum. Although it is by no means decided that the substance, as used by bakers, is hurtful, it is advised that it should be prohibited.

Cream of Tartar.—This substance is one of the articles which are subject to gross adulteration. Only 18 samples were examined, but these were considered to be enough, in view of the character of the results. Six were of satisfactory purity. Eleven contained sulphate of lime, varying from seventeen to ninety per cent., 3 having nearly the latter figure. Two contained no cream of tartar, but consisted instead, the one of sulphate of lime, alum, and acid phosphate of lime, and the other of alum, acid phosphate, and potato starch. Corn starch was also found in large proportion in one of the lime sulphate powders. Considering the use of cream of tartar in baking, its impure condition is a serious evil.

Baking Powders.—Contained alum and sulphate of lime, and were often decidedly impure.

Ground Pepper.—As ground spices in general are quite impure, Dr. Smart observes:

The examination of the ground black peppers and spices shows to what extent adulteration may be practiced when its detection by the public is a matter of difficulty. The dealer himself appears to have lost the knowledge of the characters of the pure article, as out of 4 samples sent in by respectable houses in this city for the purpose of being examined, only 1 was pure. The othrs contained baked flour and rice with sand enough to prove the unclean condition of the pepper itself.

Out of 18 samples of ground cayenne pepper only 2 were pure. Out of 23 specimens of commercial ground mustard, 21 were adulterated. Out of 36 samples of ground cinnamon, only *one* was the genuine article! The usual adulterants are colored clays, roasted wheat, beans, rice, sawdust, etc., but, fortunately, no red lead.

In confectionery the red colors are generally harmless cochineal, but the yellows are often from salts of lead. Some yellow lemon balls yielded seven grains of lead chromate to the pound of candy.

THE LIQUEFACTION OF OZONE AND ITS COLOR IN THE GASEOUS STATE.

By MM. HAUTEFEUILLE and J. CHAPPUIS.

MM. HAUTEFEUILLE AND J. CHAPPUIS have recently published some notes on this subject, which supply interesting information. Ozone, such as one usually prepares, possesses so little tension in oxygen, at most 53 mm., that the physical properties of this body are hardly known and distinguished from those or oxygen. The difficulties which Soret has so ably overcome in determining the density of ozone by operating on weakly ozonized oxygen are known. One of the fixed physical properties of this body is its heat of formation, which was accurately determined by Berthelot, in spite of the state of dilution in which it is found on leaving the apparatus for ozonization. The preparation of a mixture very rich in ozone is then the first condition to be fulfilled, in order to acquire new notions of this curious body. We have already established the fact that the isomeric transformation of oxygen submitted to electricity obeys simple laws, and that the proportion of ozone increases but very little with the pressure for every temperature, whereas, in passing from 20° to —55°, the proportion of ozone increases fivefold. Removed from the action of electrical discharges, the mixture of oxygen and ozone ceases to be a homogeneous and balanced system; in spite of that, the mixture is preserved without appreciable alteration as long as a constant temperature is maintained, if we operate on it below 0°. This relative stability of ozone allows us to compress the mixture, and to obtain the tensions of ozone of several atmospheres. As it is necessary to prepare ozone, destined for these experiments, under the strongest possible tension, one must ozonize oxygen at a very low temperature. Consequently the oxygen remains a quarter of an hour in an apparatus of alternating discharges, whose concentric tubes of thin glass are dipped into chloride of methyl, then one passes it into a test tube, terminated by a capillary tube of the Cailletet apparatus. This reservoir, of about 60 c.c., at first empty and kept at —23°, not being able to fill itself at one time under a pressure approaching 760 mm., is put rapidly in communication, five times successively, with the electric apparatus, the capacity of which cannot exceed 20 c.c. In a quarter of an hour one succeeds by this method in filling the test tube with a mixture of oxygen and ozone, very fully charged with the latter gas. The test tube is then taken away from the chloride of methyl and separated from the electric apparatus, and the gas which it contains is driven slowly back by mercury, cooled to 0° in a capillary tube maintained at —23°. The mercury which transmits the pressure of the hydraulic press does not impoverish the gaseous mixture as quickly as might be feared; a solid glaze is formed on the surface of the metal, which rapidly limits the action; the heating of the gas during the compression is more formidable. In spite of these difficulties one succeeds in increasing the tension of the ozone to a considerable degree. From the first working of the piston, the capillary tube becomes of an azure blue; this coloration is intensified in proportion as we reduce the volume of gas; and if the tension of the ozone is brought by the compression to be one of several atmospheres the gas is indigo blue, and the meniscus of mercury, seen through the gas, is then of a steel blue. The blue color of the gas becomes less intense, and the mercury regains its usual metallic appearance as soon as the tension of the ozone diminishes. The preceding mixture contains enough ozone for one to observe a thick white mist at the moment of the expansion which succeeds a compression of 75 atmospheres. It is not then necessary to compress the ozonized oxygen as much as the pure oxygen—300 atmospheres—in order to determine by a sudden expansion the momentary formation of a mist, a certain sign of liquefaction or even of solidification.

A comparative study of the mixtures of oxygen and ozone, and those of oxygen and carbonic acid, shows that in very comparable conditions the expansion ought to be sensibly stronger with the ozone than with the carbonic acid for one to begin to perceive a mist. The ozone would then be a little easier to liquefy than the carbonic acid. The mixture of oxygen and ozone contains an explosive gas, and should always be compressed slowly and cooled; for if one does not meet these conditions the ozone decomposes with the escape of heat and light, and there is a loud report accompanied by a flash of yellowish light. Berthelot has found that the transformation of oxygen into ozone absorbs 14 cal. equivalent to 8 (0²=24 gr.); the ozone may then be placed beside explosive gases; our experiments show that, like them, this body is susceptible to sudden decomposition.

One may also observe a portion of these new facts by compressing the oxygen which has gone slowly through the electric apparatus at ordinary temperature; for if we compress this gas rapidly in a capillary tube, placed in some water at 25°, we often destroy the ozone with explosion, but if this same gas is cooled at —23°, the ozone which it contains may be brought to a tension of 10 atmospheres, and may be preserved for hours in these conditions of temperature and pressure, if the gas is separated from the mercury by a column of sulphuric acid.

It is ascertained then almost equally clearly as in the preceding experiment that the ozone is a gas of a beautiful azure blue, for its color is so intense when we increase its density tenfold, that we have been able to see it in a tube of 0·001 m. internal diameter, when we were operating in a very poorly lighted room in the laboratory of l'Ecole Normale. It is then established that ozone under a strong tension is a colored gas—but may the same be said of ozone at the tension of some millimeters? The blue color characterizes the ozone as surely as its smell, for at all the tensions we find it on examining the gas to a sufficient depth. It suffices in order to make this manifest to interpose between the eye and a white surface a tube of 1 m. in length, traversed by the current which has passed through the electric apparatus of Berthelot. The color which the gas then possesses reminds one of the blue color of the sky. This blue is more or less deep, in proportion to the time the oxygen has remained in the apparatus, and it is consequently more or less rich in ozone. As soon as we stop the electric tube the coloration disappears, the ozonized oxygen being replaced by pure oxygen.

The following numbers, from a paper by the same authors in *Comp. Rend.*, are of interest, as showing the exact influence of temperature and pressure on the ozonizing of oxygen. Diminution of pressure does not tend to increase the amount of ozone produced, but decreased temperature exerts a marked action in increasing the amount of oxygen transformed into ozone:

Tension of oxygen.	Tension of ozone.				Proportion of ozone by weight.			
	—23°.	0°.	20°.	100°.	—23°.	0°.	20°.	100°.
760	108·70	82·84	58·96	—	0·214	0·149	0·105	—
380	51·68	38·76	31 54	1·48	0·204	0·152	0·125	0 0117
300	40·20	30·60	22·20	—	0·201	0.1525	0·112	—
225	24·80	22·95	15·52	0·088	0·191	0·153	0·104	0 0118
190	22·70	16·58	10·62	—	0·181	0·137	0·089	—

THE OXIDATION OF ALCOHOL.

WHEN a dilute or alcoholic fluid is exposed to the action of free oxygen, the latter gradually combines with the former, and according to the generally received opinion, acetic acid is the product of the change. The formation of acetic acid may be expressed in chemical notation as follows:

C_2H_6O	+	O_2	=	$C_2H_4O_2$	+	H_2O
Alcohol.		Oxygen.		Acetic acid.		Water.

This oxidation is brought about through the influence of a certain ferment called *Aceti mycoderma*, but other organisms are also capable of inducing the same change. Acetic acid, however, can be formed from alcohol without the agency of organized ferments. Dobereiner's celebrated experiment proved that the vapor of alcohol was converted into acetic acid by the agency of porous platinum, which possesses the remarkable property of condensing gases upon its surface, and thus the alcohol and oxygen are brought into sufficiently close contact to combine. Other porous materials besides spongy platinum possess this power, although, perhaps, not to the same degree; but it is right to mention that, according to Pasteur, the oxidation of alcohol into acetic acid is due to the intervention of one of the oxidizing ferments. The cells of these organisms probably act much in the same manner as the spongy platinum—namely, by condensing the oxygen within them, and thus, by rendering it more concentrated, making its energy greater. In a dilute alcoholic fluid like beer, we have all the conditions favorable to the production of acetic acid, and the change is undoubtedly hastened by the porous character of the wooden vessels in which beer is usually stored. Even if the pores of the wood do not possess the power of converting alcohol into acetic acid, which Liebig and many other chemists claimed for them, they at least serve as efficient carriers of the minute organisms which, according to Pasteur, are the principal agents in the phenomena of acetification. In drawing attention to the changes in the oxidation of alcohol, which have so much interest for brewers on account of their disastrous effects on beer, it is necessary to point out that there is an intermediate product. Midway between alcohol and acetic acid there is a substance called aldehyde; as its name implies, it is alcohol deprived of hydrogen, and its formation and subsequent conversion into acetic acid is explained by the following chemical equation:

C_2H_6O	+	O	=	C_2H_4O	+	H_2O
Alcohol.		Oxygen.		Aldehyde.		Water.

It will be seen that the change is really an oxidation of the alcohol, although the oxygen acts by removing a portion of the hydrogen. The subsequent conversion of aldehyde into acetic acid by means of another equivalent of oxygen is expressed by the following equation:

C_2H_4O	+	O	=	$C_2H_4O_2$
Aldehyde.		Oxygen.		Acetic acid.

When the vapor of alcohol is oxidized by means of spongy platinum or other powerful oxidizing agents, aldehyde is formed in large quantities, and it is more than probable that the cells of the oxidizing ferments act in a similar manner. In this way aldehyde may often be formed in beer, and as aldehyde possesses a peculiar fruity odor and is very volatile, this body may play an important part in developing the characteristic flavors and aromas of different kinds of beer. The detection of aldehyde in beer is attended with considerable difficulty, but several investigators have identified it as

a constituent of fermented liquids, especially in wines. A few years since Habich drew attention to the presence of aldehyde in beer. Some beer had been exported from Holland to the East Indies, but was returned as sour. When it was examined on its return all traces of acidity had disappeared. According to Habich the people in the East Indies were deceived by the smell of the beer; they noticed the peculiar smell of aldehyde, and at once concluded that the beer was sour and unfit for use, and therefore returned it; during the homeward voyage the aldehyde evaporated again, and the beer did not even smell sour when the brewer received it back. The experience narrated by Habich might probably be confirmed by other brewers, but it is rare that aldehyde volatilizes when once formed, for, from its very unstable nature, it is so easily oxidized into acetic acid. Some of the compounds of aldehyde with other bodies are more stable, and also possess peculiar flavors and odors, and the curious taste of some beers may be due to the development of such bodies. In the present note we have drawn attention to the fact that the oxidation of alcohol does not result in the formation of acetic acid only; there is at least one well defined intermediate product, which is capable in its turn of combining with other substances, and in this way beer may become charged with substances which materially influence its flavor and odor. The chemical study of aldehyde and its compounds is interesting to the scientific chemist, and the outcome of further investigations into the nature of these bodies may have considerable practical bearing on the manufacture and improvement of beer.

SPECTRAL REACTION OF CHLORINE AND BROMINE.

By M. LECOQ DE BOISBAUDRAN.

IF we observe in the gas flame, by the old procedure, the spectrum of a little globule of barium chloride, the rays peculiar to this compound soon disappear, and give place to those of the oxide. Still chlorine remains for a long time in the baryta thus heated, and the destruction of the barium chloride is only complete after its volatilization. Thus on passing the induction spark over the ignited mass we see very distinctly the nebulous rays peculiar to barium chloride in addition to the narrow rays of barium. For the detection of traces of chlorine or bromine I proceed as follows: A straight platinum wire, of about ¾ mm. in diameter, is bent at its lower part in the form of a hook, or of a U. Upon the bend is melted, at white redness, from 0·001 to 0·002 gramme of pure barium carbonate, and then there is placed in the curve of the wire a small drop of the liquid to be examined; it is evaporated to dryness, and the heat is pushed for a moment to incipient redness. The fusion, partially at least, of the mass is advantageous, permitting it to spread like a varnish over the surface of the platinum wire. When it is cold, a second platinum wire, of about ¾ mm. in diameter, is brought very near (0·001 to 0·0015 meter), below the curve of the first wire and a little in advance of the slit of the spectroscope. The induction spark, not condensed, gives them a spectrum in which the rays of barium chloride or bromide may be detected. About 1-3000th of a milligramme of chlorine or bromine may thus be recognized, and doubtless with special precautions even this degree of sensibility may be surpassed, especially in case of chlorine. If the quantity of chlorine is at all considerable the wire may be heated to full whiteness for some minutes without prejudice to the rays of $BaCl_2$. The resistance of the bromide to heat seems to be much less. If the matter in question contains nitrates it is useful to expel the nitric acid with sulphuric acid, and remove this again with pure barium oxide.

COMPARATIVE VALUES OF HIGH AND MEDIUM QUALITY BARLEYS.

AT the late Congress of Brewers at Brussels, Herr Fasbender read a paper in favor of brewers using medium but sound barleys, in preference to the very high class and expensive grades which are so much sought after; and he pointed out that there was a considerable economy in the use of the first named. In a recent communication the writer has still further pressed this opinion upon the attention of brewers. It appears that Austrian brewers no longer give the preference to the most expensive and heaviest barleys, but find by experience that cheap but sound barleys, when well cleaned and screened, produce quite as good beer as the better kinds. For very choice and heavy barley ten to ten and a half florins per one hundred kilos has to be paid, while good Hungarian barley can be purchased at seven and a half to eight florins; the difference in price is thus more than twenty-five per cent., while the yield of extract in the two qualities does not differ more than from two to three per cent. As Austria produces about 40,000,000 cwt. of barley, of which only about one-half are used in brewing, they have therefore an enormous quantity at the disposal of foreign brewers. Herr Fasbender also points out that Austrian maltings are always constructed either below or on a level with the ground, and the floors are always made of somewhat porous flagstones, and that the grain is never sprinkled. In that country the malt is considered the most perfect which has the acrospire two-thirds grown, and care is taken that the rootlets never exceed the length of the grain itself. These hints and suggestions from foreign sources cannot fail to interest English brewers.

SAFETY CHECKS.

EVERY person who has to pay away a check is naturally anxious that it should not be tampered with before being presented at his bankers. For this purpose not a few ingenious and complicated processes have been devised, all of which fail to baffle the patient subtlety of the modern forger. There are, *e. g.*, checks where the part to be written on is tinted with aniline violet, while the back bears a design in ultramarine, and the paper itself is impregnated with Prussian blue. It might be thought the application of an acid to such a check for the purpose of removing the writing could not fail to decompose the ultramarine, while, on the other hand, treatment with an alkali must destroy the Prussian blue and alter the tint of the ground. Yet we have seen the writing entirely removed from an experimental check drawn upon such paper, while the respective tones of the white, the blue, and the violet were pronounced by an experienced colorist to be entirely unchanged. Such being the case, we think there is good scope for the simple and happy invention of Mr. A. A. Nesbit, F.C.S. He points out that, in order to remove writing ink, solutions must be used which are either slightly acid or either alkaline. He proposes, therefore (Specif. No. 2184, A.D. 1880), to tint checks with a dye which is affected by both acids and alkalies, but which takes one color in acids and another in alkalies. He then prints upon the document partly in an acid and partly in an alkaline ink, so that the characters, designs, lines, etc., are apparent only in virtue of their respective alkalinity or acidity. If a forger moistens such a document with a dilute acid with a view to discharge any part of the writing, the color takes the acid tint, and the words, lines, or other design disappear, and if it is placed in an alkaline solution the whole becomes alkaline, so that the words, etc., are not restored. If an alkaline solution were applied first the inscription would still disappear, and could not be revived by the subsequent application of an acid. Even if a perfectly neutral solvent were found capable of removing writing ink, it would still be impossible to alter such a check, as the acid portion of the lettering or design might be made a little stronger than the alkaline part, or *vice versa*, in which case the document, on an immersion in an alkaline solution, would be blurred.

THE ACIDITY OF MALTS.

WE have repeatedly urged in these columns the importance of checking the development and determining the quantity of lactic acid in malts. The combined experience of many practical brewers has led to a well established opinion that lactic acid is decidedly detrimental to the durability and flavor of beer brewed with it. Some recent experiments at the Wiehenstephen School of Brewing confirm this view, if confirmation were required. Miniature mashes were made by digesting 50 grammes of malt in 200 cub. cent. of cold water, which was then gradually heated to 75° C., and after standing one hour diluted to 400 c.c. and filtered; to these different mashes varying quantities of lactic acid were added, ranging from 0·032 gramme to 0·6 gramme. On testing the resulting worts it was found that with an increase of lactic there had been a decrease of diastasic power, as indicated by the decrease in the quantity of sugar formed. As might be expected, the addition of lactic acid caused more of the albuminoid and mineral constituents of the malt to be extracted. The proportion of lactic acid in malt having thus such an important influence on the composition of the resulting worts, it behoves all brewers to acquire some knowledge of the processes employed by chemists for determining this acid. In previous numbers we have on several occasions given suggestions in this respect, but in an early issue we hope to devote a more extended article to this important subject.—*Brewers' Guardian.*

SYNTHESIS OF SALICYLIC ACID.

By EDGAR F. SMITH, of the Laboratory of University of Pennsylvania.

UPON heating one part of copper benzoate with about three parts of distilled water in a sealed tube at a temperature of 180° C., for a period of three hours, a large quantity of cuprous oxide separated. The contents of the tube were then removed to a rather large beaker, acidulated with hydrochloric acid, and the solution super-saturated with hydrogen sulphide. The filtrate from the copper sulphide contained, of course, a considerable amount of benzoic acid, which was removed by distillation in a current of steam. The residual liquid reduced to a small volume gave a crystallization of needles, fusing constant at 156° C., and afforded with ferric chloride the characteristic coloration given by salicylic acid. The salts also proved the presence of the latter.

The experiment repeated gave the same result. A quantity sufficient for analysis was obtained, although its separation from the benzoic acid was attended with difficulty. In one or two instances the method was slightly modified. An aqueous solution of benzoic acid and an ammoniacal solution of cupric oxide were employed. The mixture was heated as usual, but it was necessary to increase the temperature to 220° C. The yield of salicylic acid in either case was never very abundant.—*American Chemical Journal.*

HOMOFLUORESCEINE, A NEW COLORING MATTER.

By H. SCHWARZ.

ON heating solutions of oreine with caustic alkalies and chloroform the liquid becomes purple and then fiery red, and on dilution shows a strong greenish-yellow fluorescence. This reaction is exceedingly sensitive. On neutralizing and adding bromine water a compound is formed from the fluorescent coloring matter resembling eosine; its alkaline alcoholic solutions appear cherry red by transmitted light with yellow fluorescence. The author describes homofluoresceine, its salts and derivatives. Though many of these compounds have splendid colors, only the nitro-derivatives are suitable for dyeing. Hexa-nitro-monooxy-homo-fluoresceine dyes silk a brilliant orange, the penta-nitro-diazo-amido-monoxy-homo-fluoresceine compounds a gold yellow, and cyamic acid a light reddish-yellow.

THE ACTION OF DIASTASE ON STARCH.

ACCORDING to most investigators the ultimate products of the action of diastase on starch are maltose and achroodextrine. M. Herzfeld has studied this reaction, and has succeeded in isolating a gummy substance, which is very soluble in water, and to which he has given the name of maltodextrine; he considers it almost identical with the γ-dextrine of Bondonneau; the latter possesses a rotatory power of $\alpha = 164·2$ and does not reduce Fehling's solution, but maltodextrine has a slightly higher rotatory power ($\alpha = 173·4$), and reduces Fehling's solution to a slight extent. By studying the chemical relations of maltodextrine to other bodies, M. Herzfeld has come to the conclusion that it is a definite principle, and is clearly distinguished from achroodextrine and erythro-dextrine.

DETECTION OF IODINE IN BROMINE.

By A. JORISSEN.

A FEW drops of the bromine in question are placed in a small porcelain capsule, 30 c.c. of a solution of potassium chlorate, saturated in the cold, are added, and the liquid is boiled till colorless. The solution is then poured into a test-tube, allowed to cool, mixed with a few drops of a solution of morphine sulphate and a little chloroform. If the chloroform takes a violet color, iodine was present in the sample. The morphine solution is prepared by disolving 0·5 gramme morphine in an excess of dilute sulphuric acid, and diluting to 50 c.c. In examining potassium bromide the solution is mixed with 2 or 3 drops of pure bromine water and a few c.c. of a cold saturated solution of potassium chlorate, and further treated as above.—*Zeitschrift für Analytische Chemie.*

BOTANY.

Leaves Placing Themselves at Right Angles to Incident Light.—On December 16, 1880, Mr. Francis Darwin read before the Linnæan Society, two important papers, one on "The Power Possessed by Leaves of Placing Themselves at Right Angles to Incident Light," the other entitled "The Theory of the Growth of Cuttings, illustrated by Observations on the Bramble, *Rubus fruticosus*;" two papers which, though relating to different questions in the physiology of plants, have nevertheless much in common. Both of them bear on the relationship between the external and internal conditions of life; between external forces, such as light and gravitation, and the constitution of the organisms on which these forces act; and both tend to show the importance of recognizing in plants those specific forms of sensitiveness which may be said to determine the results which will follow external changes. We have, says *Popular Science Review*, to thank Mr. Francis Darwin and the authorities of the Linnæan Society for the following abstract of these papers:

I. The behavior of leaves in relation to light may be illustrated by the cotyledons of a seedling radish; if it is illuminated from above, the cotyledons are extended horizontally, and are thus at right angles to the direction of incident light. If the seedling is then placed at a window, so that it is lighted obliquely from above, and if the stem (hypocotyl) is prevented from bending, the cotyledons will accommodate themselves to the changed conditions by movements in a vertical plane. The cotyledon which points towards the light will sink, while the other will rise; and thus both will become once more at right angles to the incident light.

Two theories have been proposed to account for this property of leaves. The first is that of Frank,* who ascribes to leaves, and to some other organs, a specific sensitiveness to light, called "Transversal-heliotropismus," or "dia-heliotropism."† Just as an ordinary heliotropic organ has an inherent tendency to become parallel to incident light, so a diaheliotropic organ has an inherent tendency to place itself at right angles to the direction of the light. The two classes of organs differ from each other exactly as some creeping rhizomes do from ordinary stems; the rhizome tends to extend itself horizontally under ground, while the stem above the surface grows vertically upwards.‡

A different theory has been proposed by De Vries,§ whose views are supported by Sachs ‖ with additions or modifications. According to these views it is not necessary to assume the existence of any special kinds of heliotropism, since the phenomena might result from the ordinary forms of heliotropism and geotropism acting in concert. Thus, in the case of the seedling radish illuminated from above, if the cotyledons are apheliotropic (negatively heliotropic) and apogeotropic (negatively geotropic), it is possible that they might be kept in equilibrium by these opposing tendencies. The tendency to move away from a vertical light will make the cotyledons curve downward toward the earth, and the apogeotropism, or tendency to move away from the center of the earth, may exactly balance the downward tendency, so that the cotyledons remain horizontal. Besides the various geotropic and heliotropic tendencies, there are other modes of growth which may enter into the combination. In some cases there is a natural preponderance of longitudinal tension and growth along the upper surface of the petiole, so that, owing to impulses arising within the plant there is a tendency for the leaf to curve downwards;¶ this tendency is called longitudinal epinasty, or simply epinasty; the opposite tendency is called hyponasty.

According to the theories of De Vries and Sachs, epinasty may be opposed by heliotropism, or by apogeotropism and geotropism, and all these opposing forces may combine in producing an equilibrium.

The object of the present paper is to test the relative values of the two above described theories—that of Frank and that of De Vries and Sachs.

The method employed was to fix the plants under observation to a horizontal spindle, which was kept in slow rotation by clockwork. This instrument (called the "clinostat") has been employed by Sachs for the study of ordinary heliotropism; light is admitted parallel to the axis of rotation, and the plants are thus subjected to a constant lateral illumination, while they are freed from the disturbing influence of gravitation; for, owing to their being kept in constant slow rotation, there is no reason why they should bend geotropically in one direction more than another.** On the same principle the behavior of leaves which place themselves at right angles to the incident light has been studied. If a plant with horizontally extended leaves which has been illuminated from above, is fixed on a slowly revolving horizontal spindle, so that the axis of the plant is parallel both to the axis of rotation and to the direction of incident light, we shall have a means of testing the opposing theories above mentioned. The plant's leaves will still be illuminated by light striking them at right angles; therefore, if Frank's theory is the right one, they ought to remain in this position. But if De Vries and Sachs are correct in their views, the leaves ought *not* to be able to remain at right angles to the incident light since geotropism has disappeared, which was one of the tendencies necessary to keep the leaves in a position of equilibrium. A considerable number of experiments were made with the celandine (*Ranunculus ficaria*), the results of which are decidedly in favor of Frank's views.

The leaves of the celandine are sometimes extremely epinastic, so that they press against the ground; and when a plant is dug up it often happens that the leaves, being released from the resistance of the soil, curve nearly vertically downward. If such a plant is fixed on the clinostat in the position above described, the leaves will be pointing away from the light, so that if the leaves were apheliotropic, as might be expected according to De Vries' theory, the leaves would remain pointing away from the window. But this is not the case; they move forward until they are approximately at right angles to the light, and then come to rest. Again, if a celandine is placed in the dark, its leaves rise up so as to be highly inclined above the horizon; if the plant is then placed on the clinostat, the leaves (which now of course point toward the light) again accommodate themselves by curving backward until they are at right angles to the light. Thus the leaves cannot be called heliotropic or apheliotropic; we are forced to believe that under the influence of light they are able to move in either direction which may be necessary to bring them at right angles to the light. The

* "Die natürliche wagerechte Richtung von Pflanzentheilen," 1870.

† Darwin, "Power of Movement in Plants," p. 488.

‡ See Elfring, in Sachs' "Arbeiten," 1879.

§ Sachs' "Arbeiten," i., 1872.

‖ Sachs' "Arbeiten," ii., 1879.

¶ Or more accurately, in the direction in which the morphological lower side of the petiole is directed.

** See Sachs in his "Arbeiten," Bd. ii., 1879.

other experiments with *R. flearia*, the details of which we omit, lead to the same general result. Besides a few observations on *Vicia*, *Cucurbita*, and *Plantago*, a series of experiments were made on seedling cherries, and these lead to a somewhat different result. A cherry plant, growing in the open air, has its leaves approximately horizontal, and when placed on the clinostat, as above described, the leaves are unable to remain at right angles to the light, but curve backward, so as to become parallel to the stem of the plant. The petioles are shown not to be apheliotropic, but to be powerfully epinastic, so that they move in the manner described when unopposed by apogeotropism.

It is clear, therefore, that the horizontal position of the leaves of seedling cherries growing normally must largely depend on the balance struck between epinasty and apogeotropism, in accordance with the views of De Vries and Sachs. But since these forces obviously cannot produce the power of accommodating itself to the direction of incident light which the cherry possesses, we must assume that some kind of heliotropism enters into the combination.

The view to which the present research lends most probability is, that diaheliotropism (transverse-heliotropism) is the really important influence at work. In the case of the celandine we have seen that the sensitiveness to light is strong enough to determine the position of the leaves, although the natural balance is disturbed by the annihilation of geotropism. It seems probable that an essentially similar state of things holds good in the case of the cherry. When the plant is growing normally, it trusts to epinasty and apogeotropism to produce an approximate balance, the final result being determined by the stimulus of light; but when the balance is disturbed by placing the plant on the clinostat, the light-stimulus is not strong enough to produce a condition of equilibrium.

This view is the same as that given in *The Power of Movement in Plants*, and is in accordance with the principal there laid down—that the chief movements in plants are due to modifications of the circumnutatory motion.

Theory of the Growth of Cuttings.—II. When a cutting—for instance, a piece of a willow branch—is placed in circumstances favorable for growth, it produces roots at its lower end, while the buds at its upper end grow out into branches. The experiments of Vöchting* on the growth of cuttings were made by suspending pieces of stems and branches, etc., in large darkened jars, the air in which was kept constantly moist by a lining of wet filter paper. The cuttings were suspended both in the normal position, that is, with the upper end upward, and also upside down. Vöchting found, as a general result, that there is a strong tendency for the roots to appear at the *basal* end,† and the branches to be developed at the apical end, whether the cutting had been hung apex upward or downward in the glass jar.

Vöchting believes that the growth of roots at the base, and of branches at the apex of a cutting, is determined chiefly by an innate inherited growth tendency. When the knife divides a branch into two cuttings, it separates a mass of identically constituted cells into two sets; one forming part of the apex of the lower cutting, and another set which forms part of the base of the upper cutting. And under appropriate circumstances one of these sets of cells might develop into roots, the other into adventitious buds. It is Vöchting's belief that the morphological positions of these sets of cells, the fact of one being at the base, and the other at the apex of a cutting, chiefly determines the course of their subsequent development. The idea may be expressed somewhat familiarly, by saying that each cutting into which a branch is divided is able to distinguish its base from its apex, and can tell where to produce the growth of roots and buds, by means of an internal impulse which is independent‡ of the external forces, gravitation and light.

The theory which Sachs has brought forward in his paper on *Stoff und Form der Pflanzenorgane*§ is entirely opposed to that of Vöchting. Sachs conceives that Vöchting's "morphological force" is not a hereditary tendency, but a tendency produced by the action of external forces during the growth of the formative cells. Thus Sachs believes the force of gravity acting on the developing cells of an organ produces on it a predisposition or enduring impulse, which manifests itself in the results which Vöchting ascribes to a hereditary force. The mode in which Sachs believes gravitation to act is interesting, not only in itself, but also as a modification of a theory of Du Hamel's. It is assumed that difference of material is a necessary concomitant of difference of form, and that accordingly the materials from which roots are formed are chemically (used in a qualified sense) different from those which supply the branches. Sachs' theory supposes that the growth of roots or buds at a given place will be determined by the distribution of the root and branch-forming materials, and that the distribution of these materials is regulated by the force of gravity. The root material is in a certain sense geotropic, and flows downward, the branch material having the opposite tendency. But they are not supposed to be simply geotropic; the tendency of the root material to flow to the base of a branch is carried on after the branch has been made into a cutting, and hung upside down, so that the root material flows upward toward the base of the cutting, because that end was originally downward, and *vice versa* with regard to the branch forming matter.

The observations on the bramble, which form the subject of the present paper, were carried out with the object of deciding, for a particular case, whether the growth was determined by a morphological force, or by the after effect of gravitation

The long sterile shoots of the bramble are well known to possess the power of rooting at their ends. The terminal bud is thus protected during the winter, and the store of nutriment contained in the club-like thickened end of the branch forms a starting point for new growth in the spring. It is commonly the long pendent branches growing vertically downward that reach the ground and form roots. It might, therefore, be supposed that gravitation determines their growth at the *lower* end of the branch, just as, in a cutting made from an erect willow branch, the roots grow at what was originally the lower end. But observations made on brambles under certain circumstances show that this is not the case. When brambles grow on a steep bank, the majority of the branches grow down hill at once, or else straggle more or less horizontally along the bank, and finally turn downward. But a certain number of branches grow uphill, and some of these take root at the apex. When, therefore, we find on the same individual plant some branches forming roots at the physically lower, and others at the upper end, we may feel sure that the distribution of root-growth in the bramble is not determined by gravitation or its after effect. We must believe that there is a morphologically directed impulse which tends to the production of roots at the apex of the branch, whether the direction of its growth has been upward or downward. It is true that in the observed cases the extreme end of the branches was bent, so that from one to nine inches was inclined at from 2° or 3° to 5° below the horizon; but it can hardly be imagined that this fact influences the growth of roots at the apex, and experiment shows that it is not necessary that even a single inch should be inclined below the horizon. A bramble branch was tied apex upward to a vertical stick, and was surrounded by damp moss, and covered with waterproof cloth; under these circumstances a plentiful crop of roots sprang from the terminal part of the branch. This result, combined with observations made with brambles growing on a steep bank, shows conclusively that an internal impulse or morphological force regulates the growth of roots in the bramble.

When a cutting is made from a bramble, the only growth that takes place is the development of the axillary buds at the apical end of the cutting. Under certain circumstances these side shoots take on a root-bearing function. They are stunted in growth, being perhaps 10 or 12 mm. in length, or 3 or 4 mm. or more in breadth; they assume a peculiar club-like form being thicker at the apex than at the base, and are clothed with rudimentary scale-like leaves, from among which a number of relatively large roots spring forth. In order to determine whether the production of this root-bearing type of shoot is determined by gravitation, or by a "morphological force," cuttings were made from branches whose direction of growth was above the horizon. Such cuttings were hung apex upward, and it was found that the most apical buds were capable of developing, under these circumstances, into the root-bearing type of branch. Similar rooting side shoots are produced by cuttings made from branches which have grown beneath the horizon, and it is, therefore, clear that gravitation is not the determining force in this form of root production. When the end of a branch is injured, as often occurs when a bramble grows along the ground near a pathway, the most apical bud or buds produce branches which take root, instead of the parent branch; either an ordinary branch is produced, which after a certain course of time makes roots at its extremity; or under certain circumstances the stunted, club-shaped, root bearing side shoots may be developed, whose whole formation is devoted to the bearing of roots. It is, therefore, clear that the production of such shoots in cuttings is the same process that occurs in branches injured in a state of nature—a process which enables the branch to perform the function whose normal performance has been interfered with. And this fact enables us to see in what way a morphological growth impulse is better fitted for the requirements of the case than any possible dependence on gravitation as a guiding force. When the end of the branch is injured, it is clear that if a branch is to be developed to carry on the function of the injured apex, it will have the best chance of success if it starts from the position already gained by the end of the original branch before it was injured. Therefore the bud which is nearest to the injured apex will be the most suitable one to be developed into a new branch. And this is equivalent to saying that the place where the new development is to take place is determined morphologically, and not by gravitation.

Thus in the bramble the behavior of cuttings is a repetition* of the normal process of restoration of a deranged function in the plant; how far this is the case with other plants must remain at present undetermined.

* Organbildung im Pflanzenreich." Bonn, 1878.

† The basal is that end of a cutting nearest to the parent plant; the apical end is the opposite end.

‡ Vöchting states distinctly that gravitation and light do affect the positions in which organs are developed in cuttings, but he considers the internal impulse to be a stronger determining cause.

§ "Arbeiten des Bot. Inst. Würzburg," 1880, p. 452.

* See Vöchting, "Organbildung," p. 107.

CULTIVATING CORN.

An interesting discussion on this subject occurred at the Elmira Farmers' Club on the 25th ultimo, in which the practicability of securing fields clear of weeds was in turn affirmed and questioned. Several members had experienced much difficulty in killing the weeds which had always found abundant entrance among their corn, and although they planted in hills and cultivated both ways, large numbers of weeds remained to infest the crop and perpetuate themselves. One member said that with the best he could do, many weeds would remain, and he found it hard to kill them even when "only three or four inches high." At least one member (Mr. A. Donald), however, had pursued a different and successful course. He planted in drills, and when the cultivation was completed for the season his field was clean. The rows were straight, and his cultivator was adjusted to run close to them. The great point with him is never to allow the weeds to get "three or four inches high," as another member had stated, but the cultivator is kept going *ahead of the weeds*, and the field is *kept clean*. The few weeds which remain are pulled out by hand, but this is a light task. Mr. Donald continues the work of cultivation after the plants are higher than the horse, or when the corn is in tassel. Another member, Mr. J. F. Beecher, fully indorsed this thorough practice, and said that he cultivated his corn four or five times [ten would be better], and even in harvest time he threw aside other work to cultivate his corn when necessary, as being the more important of the two, and when the work was kept up even till the corn hid the horse, he had the largest crops.

The mode which we have adopted for years with the best success, is to plant the corn in drills, or rather in small hills of about two stalks each, eleven inches apart—the rows being three and a half feet. Before the corn is up, the whole surface is pulverized with a smoothing harrow (any small slanting tooth harrow will do), which is done quite rapidly, many acres being done in a day. This harrowing is repeated soon after the appearance of the young corn, and again and again every five days till the plants are a foot high. This repeated brushing of the surface pulverizes and grinds to powder all the young sprouting weeds before they can reach the light, while the large, strongly rooted corn plants are uninjured. The teeth of the harrow pass in the row and among the corn, and clean out every weed. The result is, we have clean rows without ever touching a hoe to them. After the corn is a foot high, the cultivator is passed every week till the corn is as high as the horse's back. As there is usually a succession of weeds, some make their appearance after the harrowing has ceased, and these are destroyed by the cultivator, the wings of which throw a small ridge against the stiff plants at the last passing, and cover what small weeds may have come up in the row. A few weeks afterward, the men go through the rows and pull out by hand the few scattered weeds which remain. When the corn is cut up in September, the field is left as clean as a floor, and the labor and expense have been far less than the usual hand-hoeing with the crop of weeds following. The quick repeated harrowing and cultivating accomplishes two very important ends—it keeps the land clean, and increases the crop by estimates from ten to twenty bushels per acre; while the drill culture, which it facilitates, still farther adds to both corn and fodder.—*Country Gentleman.*

HOT-BED FRAMES.

It is well for those intending to make hot-beds in spring to provide good substantial sashes in winter, and have them ready when needed. A hot-bed should not be a repulsive object on account of the heavy, unpainted, decaying frame and sash which is used. A neat form, neatly finished, neatly painted, and with a mass of handsome, green, luxuriant growth under the glass, constitutes a pleasing object in spring before outside foliage has appeared. Such a frame is represented by Fig. 1. If the frame is to remain entire when

Fig. 1.

packed away in summer, the corners may be held together by means of the iron straps shown in the figure. But if there is not room enough under shelter, the frame may be made so as to take apart, by withdrawing the pins from the iron loops represented in Figs. 2 and 3, when they will occupy little room till again needed.

As the wood is exposed to contact with moist earth with-

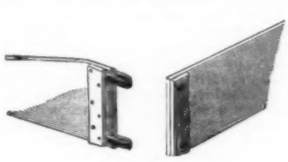


Fig. 2.

in, and to the weather without, it soon decays unless properly protected. Nothing is better than a good coating of warm coal tar, applied to the wood when it is warm and dry, and only so far up as the earth inside reaches; and nothing is much worse than coal tar for surfaces exposed to sun and weather. All exposed surfaces should, therefore, be painted, or what is better, well soaked with crude petroleum, and

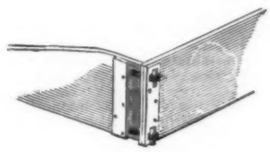


Fig. 3.

afterward covered with a coat of some adhesive paint like the Averill.

A common source of loss in hot-bed sashes is the breakage of the glass by wind, on account of the panes not being well fastened in the sash. It is important, therefore, to see that they are well secured.

A more finished frame is shown in Fig. 4, the sash on each

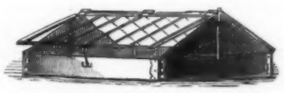


Fig. 4.

side being held by hinges at top; these being raised as required by the hooking rod shown in front. Such sash may be placed north and south, the sun shining on both sides. The chief object of the slope in the glass is to throw off the rain, less advantage resulting from the aspect of the sun's rays than is often supposed. Fig. 5 is a modification of this frame, with short sashes in the rear and longer in front.

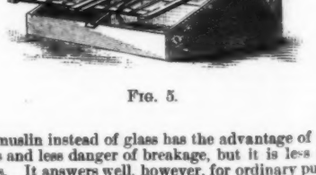


Fig. 5.

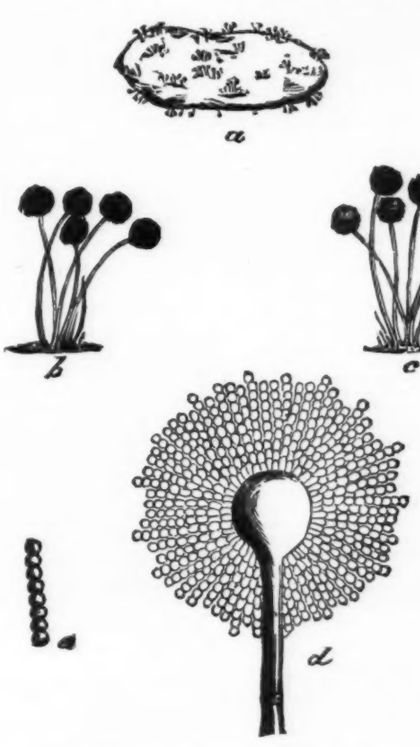
Using muslin instead of glass has the advantage of greater cheapness and less danger of breakage, but it is less perfect than glass. It answers well, however, for ordinary purposes. It is prepared by extending the cotton cloth a few inches beyond the frame, and being hemmed and provided with curtain rings a foot or so apart, strongly sewed on, it is hooked over nails outside and drawn tight. A coat of the following mixture is then applied: Four ounces of pulverized resin and one ounce of powdered sugar of lead, mixed with a quart of linseed oil, and sufficiently heated in an iron kettle to dissolve well together. This coating renders the cloth nearly transparent.

CHEESE MOULD.

THIS is a fungus plant found on bread, on preserved fruit, also on decaying fruit, on cheese, and other substances. Its scientific name is *Aspergillus glaucus*, and it is the plant which is generally meant when one speaks of "cheese mould." The well-known student of fungi, Dr. Bary, made a popular demonstration of this mould some years ago, and it is upon his description that we shall chiefly rely in explaining the growth of the plant, as shown in the engraving.

It shows itself to the naked eye as a woolly floccy crust over the substance, first purely white, then gradually covered with little fine glaucous, or dark green dusty heads. It is shown at *a* as it appears to the naked eye. More minute microscopical examination shows that the fungus consists of richly ramified fine filaments, which are partly disseminated in the substratum, and partly raised obliquely over it. They have a cylindrical form with rounded ends, and are divided into long outstretched members, each of which possesses the property which legitimatizes it as a vesicle in the ordinary sense of the word; it contains, inclosed within a delicate structureless wall, those bodies which bear the appearance of a finely granulated mucous substance, which is designated by the name of protoplasm, and which either equally fills the cells, or the older the cell the more it is filled with watery cavities called vacuoles.

All parts are at first colorless. The increase in the length of the filaments takes place through the preponderating growth near their points; these continually push forward, and, at a short distance from them, successive new partitions rise up, but at a greater distance the growth in the length ceases. This kind of growth is called point growth. The twigs and branches spring up as lateral dilatations of the principal filament, which, once designed, enlarges according to the point growth. This point growth of every branch is, to a certain extent, unlimited. The filaments in and on the substratum are the first existing members of the fungus; they continue so long as it vegetates. As the parts which assorb nourishment from and consume the substance, they are called the *mycelium*. Nearly every fungus possesses a



THE GREEN MOULD OF FRUIT, CHEESE, ETC (*Aspergillus glaucus*).

mycelium, which, without regard to the specific difference of form and size, especially shows the described nature in its construction and growth.

The superficial threads of the mycelium produce other filaments beside those numerous branches which have been described, and which are the fruit thread (carpophore) or conidia thread. These are on an average thicker than the mycelium threads, and only exceptionally ramified or furnished with partitions; they rise almost perpendicularly in the air, and attain a length of, on an average, one fiftieth of an inch, but they seldom become longer, and then their growth is at an end. Their free upper end swells in a rounded manner, as shown at *b* and *c*, and from this is produced, on the whole of its upper part, rayed divergent protuberances, which attain an oval form, and a length almost equal to their radius, or, in weaker specimens, the diameter of the rounded head. The rays divergent from protuberances are the direct producers and bearers of the propagating cells, spores, or conidia, and are called sterigmata. Every sterigma at first produces at its point a little round protuberance, which, with a strong narrow basis rests upon the sterigma. These are filled with protoplasm, swell more and more, and, after some time, separate themselves by a partition from the sterigma into independent cells spores, or conidia.

The formation of the first spore takes place at the same end of the sterigma, and in the same manner a second follows, then a third, and so on; every one which springs up later pushes its predecessor in the direction of the axis of the sterigma in the same degree in which it grows itself; every successive spore formed from a sterigma remains for a time in a row with one another. Consequently every sterigma bears on its apex a chain of spores, which are so much the older the farther they stand from the sterigma. The number of links in a chain of spores reaches in normal specimens to ten or more. This growth is shown at *d* highly magnified. All sterigmata spring up at the same time, and keep pace with one another in the formation of the spores. Every spore grows for a time, according to its construction, and at last separates itself from its neighbors. The mass of dismembered spores forms that fine glaucous hue which is mentioned above. The spores, therefore, are articulated in rows, one after another, from the ends of the sterigmata. The cell spores, or conidia, are cells of a round or nearly oval form (see *e* in the engraving), filled with a colorless protoplasm, and, if observed closely, it is found to be provided with a strong, finely verruculose, dotted wall.—*Mining and Scientific Press.*

CONVENIENT WAY TO STORE ROOTS.

A FEW days ago I called at the residence of a farmer near Newark, N. J. He keeps about sixty to seventy milch cows, for the purpose of selling milk about the city and suburbs. He had cultivated, the past season, some eight or ten acres of turnips (a variety known as the "cowhorn"), which his helpers were pulling and storing. The place prepared for the turnips was a large wagon or tool shed, built against one side of the large barn, the bottom being on a level with the natural surface of the yard. I judge that this shed is about 60 feet in length by 30 in width, and 9 or 10 feet high. Between the roof and the joists overhead, the space is filled closely with hay and straw, to protect the roots from freezing in cold weather. The outer side of the shed has vertical siding of sufficient strength to resist the pressure of a large body of turnips. The loaded wagons and carts are backed into one end of the shed and unloaded, so that the space is filled from the ground up to the covering overhead. Before cold weather has come on, stakes are set in the ground all around the outside of the shed, about 18 inches from the boarding, and other boards are placed on the inside of the stakes, and the space is filled with stable manure, well trodden down, which excludes the frost. On every side the shed is protected by a wall of stable manure, except on the side toward the barn. A narrow doorway, provided with two doors about 8 inches apart, provides easy and convenient access to the roots at all times during the winter.

Turnips are fed every day to the cows, from late autumn until the next spring, when green rye is large enough to be mowed. Last spring I noticed that many farmers in this county were cutting green rye for their cows on the 8th of May, and much of the rye was three feet in height. But this mode of storing a large crop of turnips at a small expense, and at the same time so convenient of access in cold weather, is the best that I ever met with. A large proportion of the feed given to these cows consists of brewers' grains and turnips. Every cow receives a small allowance of hay daily. Such feed produces an abundant flow of milk, which of course is not so rich as milk made from good grass, prime hay, and meal.—*S. E. T., in Country Gentleman.*

MAKING A LAWN.

THE most speedy way to obtain grass for a lawn is to apply cut pieces of turf from an old pasture. A much cheaper way is to sow grass seed. If the yard is quite limited in extent, the best way may be to lay down turf. Previous to applying it the soil should be made quite rich, mellow, and even, for two reasons. If rich and mellow for some depth, it will be more likely to afford moisture in drought, and it will impart vigor to the grass. The surface should be made very even, and the turf of uniform thickness. The soil must be uniform, for if there are hard spots, the earth will settle away from them and make an uneven surface, one of the worst things in a lawn. An old pasture having a dense soil which has been grazed short, will furnish good turf, which should be cut downward vertically with a spade ground sharp, by a stretched line, so that the pieces will fit closely together when laid down. The pieces may be a foot and a half square, more or less, and to make them of uniform thickness, place them inverted on a broad board, plank, or flagging, and scrape them with a sharp hoe to a perfectly uniform thickness. They are then conveyed to the intended spot, and if carefully laid will make a perfectly uniform surface when rolled. The work should be done as early in spring as the soil will admit, so that the grass may have an early start and send its roots down into the rich soil below before dry weather comes on. If laid later, it may require frequent watering from the water cask.

Sowing the seed has the advantage of greater cheapness, and in making a selection of the kind of lawn grass wanted. But it requires longer time to become perfected. The soil must be previously well enriched, and made fine and even. If rich enough, the seed will be more likely to germinate and to make a strong growth. If poor, the plants, even if they start, will be likely to burn out. As a manure, we should prefer mixing two or three bushels of ground bone with a load of clear stable manure, and allow the whole to ferment together, turning the heap often enough to prevent too great a heat. Or old stable manure, with about the same proportion of superphosphate well mixed through it, will answer well, and may be used at once; or old or well-rotted stable manure alone will do. The surface must be made fine and even, the grass seed sown copiously, or at the rate of three or four bushels per acre, on the freshly mellowed surface, and rolled or brushed in. It should not be covered more than about half an inch deep. It is important to sow *very early in spring*, so that the young grass may get a good root-hold before hot and dry weather. Kentucky blue grass (the June or spear-grass of the East), or *Poa pratensis*, makes the best lawn, but two years are required for it to form a good turf; it is, therefore, best to mix with it a portion of the seed of white clover and red-top to come forward sooner. And then, as soon as up a few inches, the great essential requisite comes in, namely, using the lawn-mower every five days during the growing season. This will make a coarser grass look better than the finest and best without it.—*Country Gentleman.*

TWO COMETS.

Hartwig's Comet.—This comet was discovered by Herr Hartwig at the Strasburg Observatory, on the evening of September 19, 1880, and by Prof. Harrington at the Ann Arbor Observatory on the following night. It was a bright comet, of considerable size, and for several days during the beginning of the month could be easily seen with the naked eye, being a little brighter than the well-known nebula in *Andromeda*. It was not discovered until more than three weeks after its perihelion passage, so that when seen it was quickly receding from the earth, thus rapidly becoming fainter, and by the end of the month it had become so faint that it could only be seen in the most powerful telescopes. It was a bright diffuse comet, with a rounded nucleus, and a tail nearly two degrees in length.

Shortly after its discovery, Prof. Winnecke pointed out the strong resemblance between its orbit and that of the bright comet of 1506, and expressed the opinion that the two were probably identical. Later investigations confirmed this view, and showed that the comet strongly resembled in its orbit the comet visible in the years 1444 and 1569. It would, therefore, appear to have a period of some sixty-two years. Dr. Schur and Herr Hartwig, from their investigations, assign to the comet a period of sixty-two and one-third years, and the following elements:

Perihelion passage, 1880, Sept. 6·5894, Berlin mean time.	
Longitude of perihelion	83° 33' 28"
Longitude of ascending node	44 33 30
Inclination of orbit	38 8 56
Eccentricity of orbit	0·97764
Semi-axis major	1·5756

The orbit of the comet extends, therefore, beyond the orbit of the planet *Neptune*; but owing to the great inclination of the orbit, it cannot be much affected by the perturbation of any of the greater planets. The comet, however, approaches very close to the orbit of the planet *Mercury*, at the ascending node; and Prof. Winnecke is of opinion that it may be due to the attraction of this planet that the comet has been introduced into the solar system with its present elliptical orbit. For though at present the orbits do not approach each other sufficiently near to enable the planet to very importantly affect the motion of the comet, at some past period the two orbits may have been nearly coincident, though now separated by the effect of perturbation.

Swift's Comet.—On Monday, October 11, 1880, Prof. Lewis Swift, of Rochester, New York, discovered a large comet in the constellation *Pegasus*, but no observation seems to have been obtained during the month in Europe. On November 7, 1880, a bright comet was discovered at Dun Echt Observatory, belonging to Lord Lindsay. A day or two showed that the two comets were identical, and revealed in the constellation *Lacerta* that the orbit of the new comet coincided very closely with that of comet 1869. This comet was discovered by Herr Temple, on November 27, 1869, in the constellation *Pegasus*, a few days after its perihelion passage, and it was last seen at Leipsic on December 31. On November 29, 1869, it was described by Dr. Vogel as a very faint object of considerable dimensions, being nearly 6′ in diameter. From observations spread over a month, Dr. Bruhns calculated a parabolic orbit, whose elements he found to be:

Perihelion passage, 1869, Nov. 20·854, Berlin mean time.	
Longitude of perihelion	41° 17 13°
Longitude of ascending node	292 40 29
Inclination of orbit	6 55 0
Perihelion distance	1·1026

Dr. Bruhns remarked, however, that this orbit did not closely represent the observations, and seems almost to have suspected the elliptical character of the orbit. The close resemblance between this orbit and that calculated from the observations made of the comet of 1880 is shown by the elements for the latter comet calculated by MM. Zelbr and Hepperger:

Perihelion passage, 1880, November 8·32198.	
Longitude of perihelion	42° 7' 4"
Longitude of ascending node	295 36 54
Inclination of orbit	7 22 5
Perihelion distance	1·1019

There can be little doubt, therefore, about the identity of the two comets, so that it would give the comet a period of a little less than eleven years. This would give:

Eccentricity of orbit	=0·7767
Semi-axis major	=4·9352

The orbit of the comet would approach, therefore, very close to the orbit of the planet *Mars*, and, what is of still more importance, within 0·5 of the Earth's mean distance of the orbit of the planet *Jupiter*, and not very far from the orbit of *Saturn*. From its mean approach to the orbit of

Jupiter, and from the near commensurability between their periods of revolution, this great planet will produce very considerable perturbation in the motion of the comet.—*Popular Science Review.*

PROGRESS IN THE SCIENCES AND ARTS FOR 1880.

CHEMISTRY AND PHYSICS.

DR. CROOKES' investigations upon the properties of highly attenuated gases, together with the discussions of other investigators upon the subject of so-called radiant matter, are pregnant with promise of future discovery. It has been found by Dr. Crookes and others that gases which, by exhaustion from glass tubes or bulbs, have become so far attenuated as to greatly increase the free paths of their molecules present in many respects the properties of the radiant forces. Hence the term radiant matter. Matter in this state projected against the sides of its inclosure by the aid of electrical repulsion produces both light and heat. It may be reflected like light, projected in a beam like light, and a beam of it may be deflected from its course by the action of a magnet. Dr. Crookes' experiments upon this subject are by far the most brilliant brought to public notice during the year, and can hardly fail to lead to important results.

The improvements in the Sprengel pump effected by Prof. O. N. Rood will greatly aid in pushing forward the investigation of the properties of highly attenuated gases, as it secures an attenuation of from one ninety millionth to one-one hundred millionth. In this invention the mercury, instead of being at once inducted into the pump, as heretofore, is passed first through an exhausted bulb to free it from air and moisture, and then is conducted through a nearly horizontal tube to the fall tube, in which a valve or seal is formed by bending the tube obliquely forward, then downward, and then upward again. A quantity of mercury retained in the bend forms an almost theoretically perfect fluid valve. Besides securing greater attenuations, the action is very much more rapid than that of this kind of pump before Prof. Rood improved it.

The discovery of a critical pressure in the liquefaction of solids, analogous to the critical temperature in the liquefaction of gases, made by Mr. Thomas Carnelley, of Sheffield, England, proved by heating ice under pressure far above its normal melting point, seems to be conceded. Below this pressure, which is 4·6 millimeters of mercury (the tension of aqueous vapor at the freezing point of water), ice remains solid though heated hot enough to burn the hand. Upon letting in the pressure the ice immediately melts. The experiments were made with ice and water in glass vessels from which internal pressure was removed by exhausting their gaseous and vaporous contents. In one instance, water was frozen in a glass vessel heated so hot that it could not be touched without burning the hand. Other substances exhibit the same phenomenon, the most notable being mercuric chloride, which will not liquefy at pressures below 420 millimeters of mercury. If the pressure be increased but slightly above the critical pressure, the ice melts at its ordinary melting point. Thus is added proof that all bodies, whether solid, liquid, or gaseous, are such by virtue of the relations of pressure and temperature to which they are subjected.

Some important additions to appliances for measuring very minute changes in the temperature of bodies have been supplied to investigators. Hitherto the thermopile has been the most sensitive indicator of thermal changes, but Prof. Langley's thermal balance is an instrument far more sensitive. It will find an extensive application both in physics and physical astronomy. Its construction is based upon the principle that a wire, when heated, will convey less electricity than when not heated. Two such wires, each leading from a strong battery, are caused to meet in a galvanometer, the index of which, pushed equally by the action of the currents in opposite directions, remains at rest. If either current be diminished ever so slightly "by heating the wire which conveys the current," the stronger current controls the index, which swings, not with a force due to the feeble heat which warms the wire, but to the power of the battery which this feeble heat controls. In each of the wires are inserted minute strips of steel rolled so thin that it takes 8,000 of them to make an inch in thickness; these strips form a prominent part of the circuit. The instrument is from ten to thirty times more sensitive than the ordinary thermopile. When mounted in a telescope it will record the heat of a man or animal in a distant field. Preliminary experiments with the instrument have shown that the almost infinitesimal amount of heat from the moon can be certainly measured by it.

Another very sensitive instrument for measuring heat which has been brought out during the year is Prof. Dufour's thermometer. A bent tube, on one end of which is a bulb covered with lampblack, is placed with the convexity downward. From the middle part of the concavity rises an index, the end of which points to measurements upon a graduated arc. The tube is filled with mercury and is nicely poised on a knife-edge support after the manner of a finely constructed balance. Beneath the point of support extends downward a vertical rod, from the lower end of which projects horizontally an arm provided with a sliding counterpoise, which is held in place on the arm by friction. In adjusting the instrument, this counterpoise is placed so that the index shall point to zero on the graduated arc. The bulb is filled with air at normal pressure and temperature. When the heat rises the air in the bulb expands, and *vice versa*. Expansion of the air pushes the mercury from the bulb, and when the air contracts external atmospheric pressure pushes the mercury toward the bulb. This causes an oscillation of the index, which indicates on the graduated arc the increase or decrease of temperature. The instrument is so sensitive that it records a difference of temperature produced in a room by the entrance thereto of a single person. Though Prof. Langley's thermal balance is far more sensitive than Dufour's instrument, the latter will prove more convenient for experiments with less minute differences in temperature which are yet beyond the capacity of ordinary mercurial thermometers, very few of which can be relied upon to indicate accurately differences less than one tenth of a degree.

The compression of gaseous mixtures has been made the subject of experiment by M. Cailletet, which indicates that there may exist a solution of one gas in another gas when one of them has been reduced to a liquid by pressure. When M. Cailletet inclosed a mixture of air and carbonic acid in the apparatus he has used so successfully for the liquefaction of gases, the liquefaction of the carbonic acid was very greatly retarded. It is even possible to compress, at zero, a mixture of equal volumes of carbonic acid and air beyond 400 atmospheres without getting a change of aspect in the tube. A mixture of five volumes of carbonic acid with one volume of air liquefies easily. At from 150 to 200 atmospheres the surface of the liquid grows indistinct, and progressively disappears; the tube then seems filled with a homogeneous substance, which thenceforward resists all pressure, as a liquid would. On diminishing the pressure the liquid suddenly reappears at a pressure constant for determinate temperatures, a thick mist is produced developing and vanishing in an instant, marking the level of the liquid which reappears at the same instant. As this phenomenon cannot be referred to the disengagement of heat by compression, the tube being kept in water which maintains the temperature constant, M. Cailletet infers that a gas may, at a high pressure, be dissolved in a liquid to form a homogeneous body. The experiment is one of the most interesting performed during the year in the domain of physics.

The liquefaction of ozone has been performed by MM. P. Hautefeuille and J. Chappuis. It is of a beautiful blue color. The liquefaction was accomplished by subjecting a mixture of oxygen and ozone to pressure at a temperature of —23° to —25°, the ozone remaining liquid at 10 atmospheres pressure. The experiment needs to be performed with great care, owing to the liability of the ozone to change into oxygen with evolution of heat and explosive violence. The beautiful blue of this substance has led to the hypothesis that the color of the atmosphere at great depths may be due to the presence of ozone.

A method of neutralizing the influence of masses of iron upon magnetic compass needles is said to have been worked out by Capt. Witt, of the Birmah, an English iron vessel in the India trade. The ship was provided with both binnacle and standard compass, as usual, both of which varied from one and a half to three points. Capt. Witt tried the experiment of surrounding the compass with a quantity of earth, which he accomplished by bedding the compass deeply in soil placed in a half cask divested of its iron hoops. It is claimed that, in some unexplained manner, this practically reduced the variation to a quantity not greater than is met with in wooden vessels. The validity of the experiment has been vouched for by Capt. Blanche, an adjuster of compasses, who has repeated the experiment, but the statement needs further verification. If the results are as stated, the discovery is a very important one, lessening the dangers of navigation in iron vessels.

Some important investigations in the expansion of materials under the influence of electrical forces have been made public by Prof. Quincke, the conclusions from which, stated as briefly as possible in the *Annalen der Physik und Chemie*, would fill a column of this publication. We cannot, therefore, here repeat them. Some of the more important are as follows:

Solid and liquid bodies alter in volume when acted upon by electrical forces. This is not the effect of heat. Most bodies expand, but some contract, notably the fatty oils. Gases do not appreciably change their volume. Some bodies take on the change instantaneously, others more gradually. Tubular condensers change simultaneously in length and volume. In some bodies, notably German glass, the change is, in some measure, prolonged after the action of the electrical force ceases. The change of volume does not result from an electrical compression of the insulating substance. The elasticity of some substances is increased and that of others diminished. The electrical piercing of bodies is due to unequal electrical expansion. Solid and liquid transparent substances become double refracting under the influence of unequal expansion. These investigations have added a long list of experimental data to electrical science.

An improvement in electro-magnets, by M. Chambria, increases the surfaces presented to each other in the core end and armature of an electro-magnet, by forming a projection on the latter which enters a hollow of the core; or the projection may be made on the core and the hollow in the armature. The putative force of the magnet is claimed by this means to be increased one hundred per cent., while the residual magnetism is weakened.

The property of phosphorescence has attracted much attention during the year as a means of illumination. Numerous practical applications of it have been suggested, and some, notably Balmain's luminous paint, have been introduced in the markets of Europe and America. An important attempt to utilize phosphorescence excited by electricity, as a means for subdividing the electric light, has been made by Dr. Phipson. He incloses barium sulphide, or some other substance which is rendered phosphorescent by the solar rays, in a Geissler tube, through which he passes a uniform electric current of feeble intensity. He claims to obtain, in this manner, a uniform and agreeable light at a cost below that of gas. It is possible that this clew, followed out, may result in something valuable. The experiment is very suggestive, and the action of the electric current upon phosphorescent substances has been comparatively little studied.

Dr. Bartoli has applied the Bunsen calorimeter to the determination of the mechanical equivalent of heat, with results strikingly confirmatory of those obtained by previous investigators, and noteworthy from their very narrow limits between extreme values. His method is to press mercury through a steel tube of so small an internal diameter as to make the velocity of outflow small enough to be disregarded, and also that the kinetic energy of the issuing may be neglected. This tube penetrates into a metallic cylinder situated within the reservoir of a Bunsen calorimeter. The quantity of ice melted in the calorimeter measures the heat developed by the efflux of the mercury. Thus previous determinations of the mechanical equivalent of heat are established on a firmer basis.

Chemistry has been steadily advancing, particularly in the department of organic chemistry. A great many new compounds have been derived which are interesting to chemists, but which at present, being not likely to find application in the industrial arts, it would not interest our readers to have enumerated.

Among the scientific triumphs the production of artificial diamonds by Mr. J. Ballantyne Hannay, of Glasgow, and the production of citric acid from glycerin, are among the most noticeable. The production of diamonds by Mr. Hannay is based upon the following reaction: When a gas containing carbon and hydrogen has its carbon set free in the presence of a stable compound containing nitrogen, the whole being under great heat and high pressure, the carbon is so acted upon by the stable compound that it crystallizes out in the form of the pure, transparent diamond. The experiments have presented great practical difficulties. Various conjectures have been made as to the probability that diamonds can be thus produced at a size and at a cost that will render them available in the arts, not merely for decorative purposes, but for the many industrial uses a substance so hard and durable as the diamond might be made to subserve in various industries. Mr. Hannay has been reported as saying that, in his opinion, this consummation may be reached.

In applied chemistry we have to note, among other advances, the progress that has been made in the manufacture of artificial ultramarine, which has become a large industry in both hemispheres, and the successful introduction of mineral tanning by the use of basic iron sulphates, etc., which has gained a starting point in Germany. A number of patents for processes of this kind have been taken out in this country, chiefly by German inventors. The use of the iron salts was, at first, found objectionable, as they made a leather which, though fine in appearance when first tanned, lacked durability. The next step was the addition of chrome salts, by which an improved leather was produced, but it would not withstand the action of water. Finally the impregnation of the leather with iron and chrome soaps (iron soap had been previously tried), in a process invented by Dr. Heinzerling, of Frankfort-on-the-Main, appears to have culminated in success. The leather looks like ordinary leather, but is lighter in weight. It is as strong as ordinary leather, and far more resistant to water, and therefore retains its softness longer.

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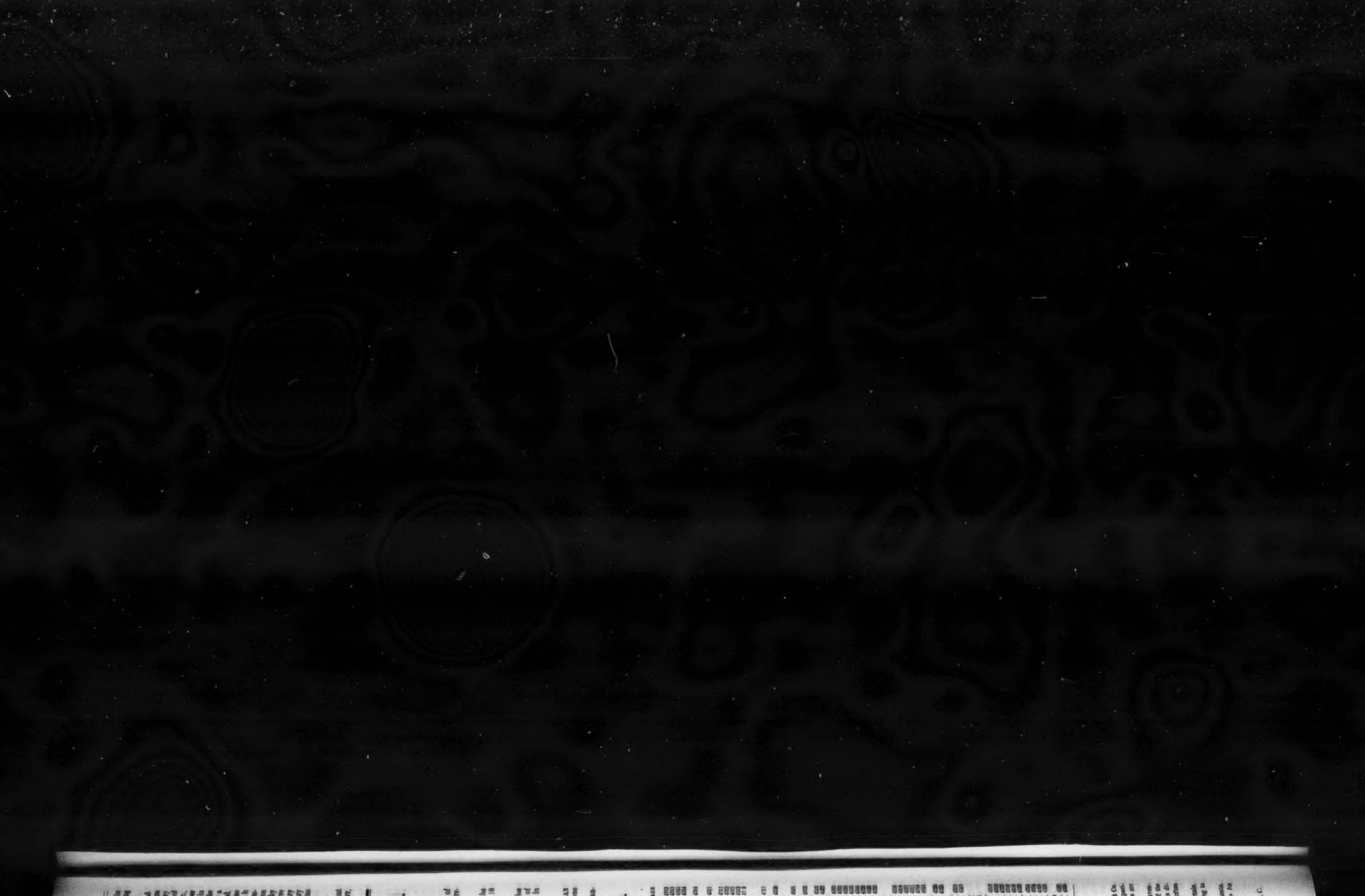
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